5-15-1974

The Formulation of a Woodworking Studio

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THE FORMULATION OF A WOODWORKING STUDIO

WOODWORKING AND FURNITURE DESIGN

15 MAY 1974

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PREFACE

This thesis is titled "The Formulation of a Woodworking Studio," but after writing this, it seems the title should be "How I Spent a Fall, Winter and Spring." Aside from fulfilling the thesis requirements, I felt that someone anticipating the opening of his own shop should be somewhat prepared. With this in mind, I have written in journal form. The result is a narrow approach to the problem. I have given an account of my experiences and have only told of the options that occurred to me. There are, of course, many differing solutions.

It is necessary first for the craftsman to define the type of work he will be doing. This will determine his space requirements as well as the equipment used. The aim, when putting the shop together, was to become a practicing, full time professional craftsman fulfilling commissions, speculative and limited production work. This should serve as background to the reading of this journal.

Information regarding prices and stock numbers has been sketchy due to unstable market conditions.

I further avoided the time aspect inasmuch as I kept no man-hour accounts. I can only say that it

has been seven months since I poured the floor during which time I have, in addition, also, worked a forty hour week, been a full time student and have become a father for the second time.

A friend was in the process of developing his own shop, and we seemed to be progressing simultaneously through the same stages. He would come over for coffee, now and then, and we would exchange problems and solutions. Reflecting on our conversations, we may have sounded like two pregnant women talking about their bumps and groans. But, as after the delivery, it was all worth it.

I am proud of my accomplishment and, yet, humbled by the knowledge that I have simply made another tool.

PART I. THE WORKING SPACE

CHAPTER I

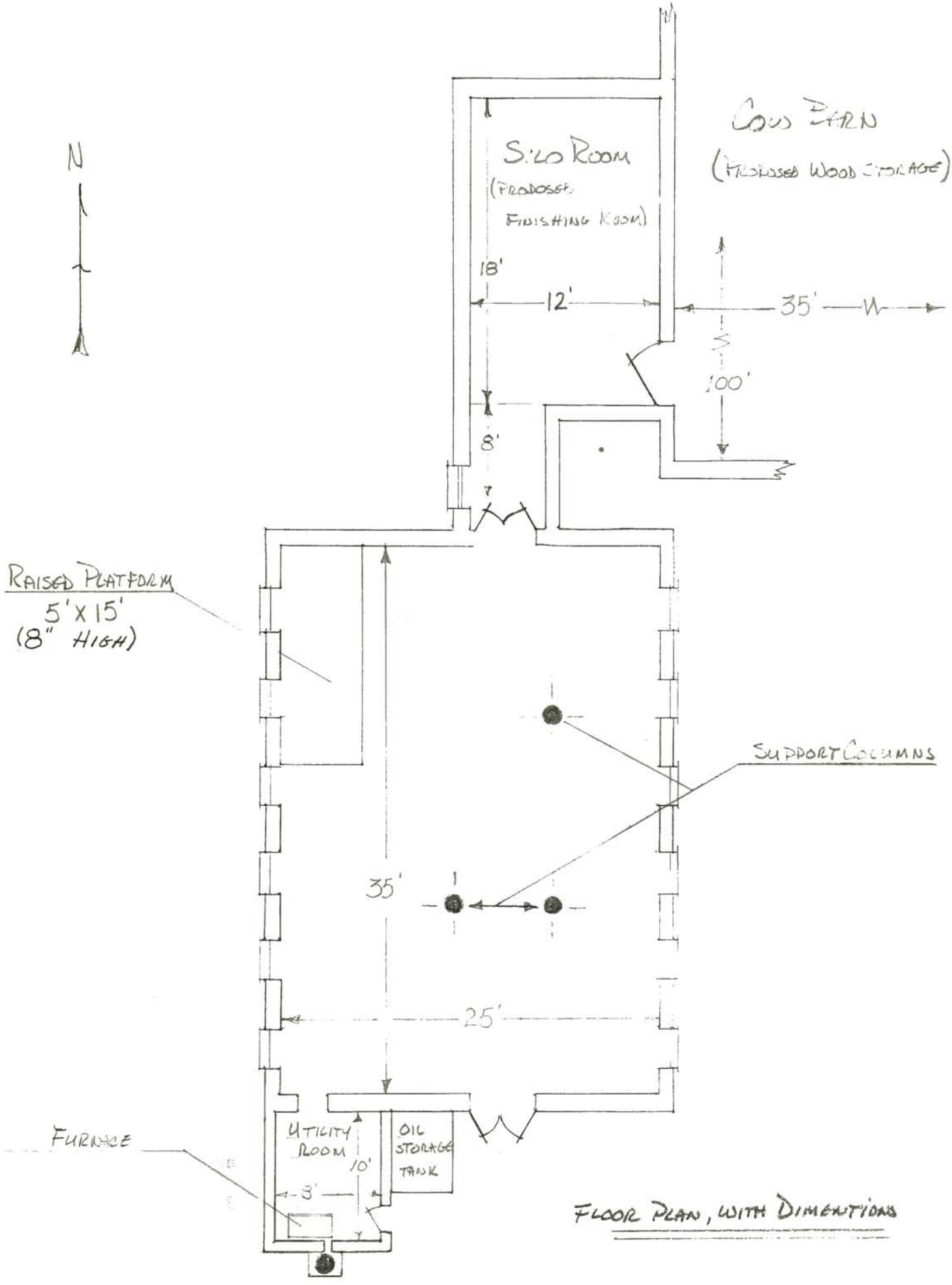
INITIAL SPACE

The building was a calf barn on a first-class semi-experimental dairy farm. The space available was not ideal but the location and price was right. I have enclosed drawings of the interior layout of the building for reference.

The working space was not ready for machinery. The first thing I did was to remove fifteen truck loads of straw and manure. Then, a thorough scrubbing. The ceiling was asbestos board, and the walls were a stucco-type swirling concrete over wire lath. The original paint seemed a metallic, possibly aluminum paint, most of which had either fallen off or, had come off during the washing. Because I planned a considerable amount of permanent installations to the ceiling and walls (wire lights, air line), I decided to paint at once instead of waiting until I had moved in.

I was sure that some industrial psychologist could have been a great help in selecting the colors for the shop. I have worked in factories where they have experimented with different color combinations to psychologically attune the worker ants to produce

more, faster, happier, etc. In this case I ended up with a very light brown with dark brown trim. At first, it tended to remind me of a high school hobby shop, but now it has turned out acceptable. I thought I did not want anything too powerful to move the ceiling down or the walls in. I, also, found semi-gloss paint preferable for use on both the walls and ceiling--the walls for ease of cleaning with a broom, and the ceiling for its light-reflecting properties. Floor and porch enamel was used for the trim and window casings.



FLOOR PLAN, WITH DIMENTIONS

CHAPTER II

POURING THE FLOOR

Next in the stage of development, a new floor had to be fitted. The original floor was a combination of a concrete center aisle with six plaster stalls. Tubular stanchions separated these mounted on concrete curbs. After this, six inch square curbs that held the stanchions had to be sledge hammered out and the floor leveled.

I discounted the use of plywood because of the expense, the difficulty of installation, and the inherent loss in floor-ceiling distance. Such an installation would have been difficult because I would have had to shim each of the supports every one or two feet in all directions. This would be a necessity because of the need for a fairly level firm surface for heavy machinery. I think with unlimited ceiling-floor space, I would prefer a wooden floor, mainly because a concrete floor is tiring to work on and if, you drop something, either a tool or your work, it is usually destroyed by the sixteen grit finish of the floor.

Even though I had never worked with concrete

before, it ended up being my choice. A friend was previously in construction work and told me how easy it was to do. All you have to do is: "(1) lay down some screeds, (2) figure out how much redi-mix you need, (3) line up some help, (4) get some beer, and (5) call the truck." They were all difficult except the beer and calling the truck.

First of all, screeds are the boards attached to a base, either earth or existing floor, from which the concrete is rough leveled. The leveling of the concrete is called rodding. The screeds are laid out using a mason line and string level. What I did was find the highest point on the existing floor and added one inch of depth to that measurement. This meant that the thickness of the concrete would vary from one inch to around seven inches, due to the unevenness of the original floor. From that reference point, I proceeded to construct the screeds using 1x2 firring strips (use 2x4's if possible!). I made four parallel strips about six feet apart, the length of the building, and shimmed the strips to the mason line level about every six inches fastening these to the existing floor using concrete nails. The shimming should be quite accurate as this determines the finished level and flatness of the floor. You have to attach the screeds firmly to the floor

because they will float to the surface before the concrete is leveled.

After the screeds were installed, I took depth readings about every two feet. From these readings, I roughly determined the quantity of concrete needed.

The basic unit of measure for concrete is the "yard." A yard is a measure of volume and is one cubic yard. The way I figured it out was to square footage, in yards, times depth in fractions of a yard. I divided the building in three units and figured from there. An example is that if the building is 25 feet by 35 feet (8 1/3 yards by 11 2/3 yards) times an average depth of 3 inches (1/12 yard) which is 8 1/3 yards by 11 2/3 yards by 1/12 yard equals 8.1 cubic yards. One should check his figures, because one pays for what one orders whether used or not. Just a note--keep in mind what to do with the overage, because the driver will want to dump it before he leaves. The redi-mix companies deliver concrete in half yard units, so in the case mentioned above, you would order 8 1/2 yards. If you come up short, neatly dam off an area between the screeds and either send the driver back for more, or if small enough, use sacrete from a builders supply.

The next step is to line up some friends to help. It took all seven of us to do my floor. Do your best

to find at least one person that knows what he is doing; it really helps. Everyone should have very old clothes and rubber boots; inasmuch as concrete destroys leather.

There are some basic tools needed; long handled shovels, garden rakes, large trowels, floats, heavy duty wheelbarrow, a straight 2x4x8 foot plank, an old 2x10x8 foot plank, approximately, and 18 inch square plywood scraps. It is, also, necessary to keep a garden hose close by. These can be rented.

After assembling all of this gear, I called the redi-mix company and told them what time I wanted the concrete delivered. They arrived about fifteen minutes late. Having been briefed as thoroughly as possible, my crew flashed into action. The truck backed up to the door. The driver filled the first garden wheelbarrow with concrete and the axle broke, the handles bent, and all the cement sloshed outside of the building. Fortunately, we had the inflatable-tire-construction type heavy duty wheelbarrow near by. After a brief wait, one beer for everyone, we were back at it. We started out in the most inaccessible point and worked towards the door where the truck was parked. The wheelbarrow took the concrete to the farthest corner where it was distributed by men with shovels and rekes. After this process was started, two men started the rodding. In the

rodding, two men stood in the corner with the straight 2x4 until there was enough concrete to start (about one to two inches above the screeds). When the concrete was deep enough, they placed the 2x4 on the two parallel screeds and started working the 2x4 longitudinally back and forth with a stroke of about six inches. If there was a low spot, the shovellers moved more concrete into the void. This process was continued until we were at the door. At this point, the driver asked me what to do with the "yard left in the truck." Not having read this book, I was unprepared and muttered, "Just dump it in the field."

A note about the truck drivers. The man that we had, and another since, were both extremely helpful. I do not know whether he was overwhelmed by seven longhairs all working so hard, even though we did not know what to work on next, or whether he just wanted to get his clean yellow boots dirty. He did help all the way through even though he wanted to be paid cash before he left. You can yell to the driver to "wet" the mix down or "dry it out," according to the way the cement is rodding (If it is getting stiff while rodding, it is too dry.).

After the rodding, it came time to "float." Floating requires the use of rectangular wooden

boards about six inches by twelve inches. A handle is attached to the center of the board. (The floats that are worn a bit seem to be better, because the rounded edges do not dig in.) In our case, two or three people tiptoed down the screeds to the starting point where the concrete was stiffening. The heavy plank was placed over the screeds for the "floaters" to kneel on. Floating requires the moving of the tool back and forth in an arc of about 180 degrees. This is done over the entire surface. The purpose of this is to bring the water-cement mixture to the surface, and cover the gumball-sized stones in the redi-mix. We started floating the floor while the rodding was still in progress. This time relationship will vary according to the size of the floor to be poured. (Generally, floating should start when the concrete is firm enough to barely support the plank but still wet enough to stick your finger in.)

Next came the troweling. After the floating, everyone had a few more beers while the concrete was setting up. We started to trowel when we could put the 18 inch by 18 inch scraps of plywood down and stand on them without denting the surface.

The trowels are used to further smooth out the surface and is done with the same action as

floating, except you can stand on the plywood and leapfrog around. Three of us did the troweling. However, if we had three more trowels, it would have been better. As I understand it, the more water-cement mixture remaining on the surface, the smoother the finished floor.

I left the outside screeds in after being told that the concrete would shrink as it ages, thus, allowing me to pull them out and fill the slots after awhile.

At this point, completely wash off all equipment and clothing or you will have to remove it later with a hammer.

We were finished with the floor. It is a good idea to leave the doors open overnight, but barricade them to keep small animals out. It could be walked on the next day, and the heavy things could be moved in carefully in about two days. I plan to paint the floor, but it has to cure for six months first. The process of painting concrete takes approximately three days.

CHAPTER III

LIGHT

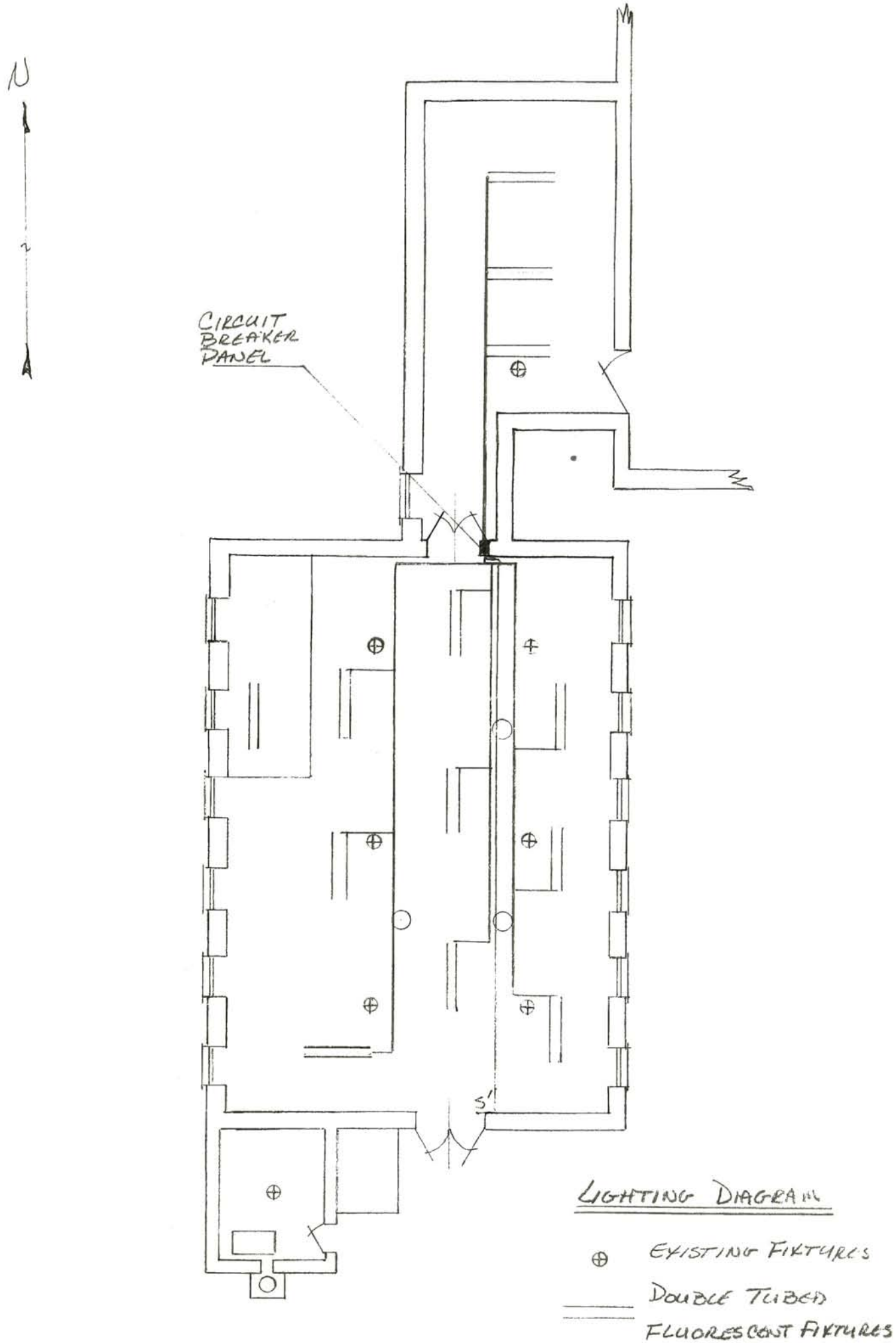
Chronologically, the next phase of development concerned lighting. I would like to mention that the electrical section of the chapter on machinery will cover the statistics of the wiring. At this point, I will, however, include a floor plan diagram.

Contained in the room were six incandescent (bulb type) receptacles. The bulbs were enclosed with heavy clear glass covers. After removing one of these fixtures and examining the condition of the wires, I decided to retain them. These were the only existing electrical facility used. This lighting was fine for farm work, but not adequate for a woodworking shop.

I engaged in research, first, by borrowing a notebook compiled by the local power company. I, also, went to the General Electric Factory Supply Center and obtained brochures (give-aways) concerning lighting. Both resources helped; mainly, in the form of making you think about the relationship between the distance to the work for location of fixtures

and the number and types of lighting sources to use.

I had unusually good natural lighting from the twelve waist-high windows, but since most of my work would be done during the dark hours, I felt that additional artificial light was essential. I decided to add six 4 foot double-tubed 40 watt fluorescent fixtures over the working space and an additional fixture over my drawing table. Because of the low barn ceiling, I did not use the reflectors available. I have used a separate circuit for the fluorescents in the event that I have a problem with the old system. This, also, afforded me the options of the amount of light-electricity used. The combination of the incandescents and the fluorescents made it quite pleasant for working.


N
CIRCUIT BREAKER PANEL
5'
LIGHTING DIAGRAM
EXISTING FIXTURES
DOUBLE TUBED FLUORESCENT FIXTURES

CHAPTER IV

HEAT

Initially, I should explain what the structure contained prior to the renovation. Being an experimental farm, calves were separated from cows earlier than usual. The point was to produce more milk, while still retaining healthy offspring. I am only explaining this so that you can understand why this barn was originally heated.

The heating system used was a coal-fired steam system. The furnace was located adjacent to the barn on the south wall in a small utility room. The steam pipes intersected the wall and were, then, suspended from the ceiling. After the first winter, the farm personnel found that the body heat from the animals was sufficient to heat the room. Consequently, they sold the furnace. This, fortunately, left me with all the elements necessary to heat the building.

The twelve windows on the east and west walls were built to accept storm windows; there was a furnace room with a chimney, and it was insulated. All of the storm windows were either broken or lost, and so for this first winter, I hastily constructed some

fir-framed sheet plastic windows. These seem to do the job even though it is a little like living in a "London fog." The plastic sheet is translucent--not transparent.

There were, then, a number of heating unit options open to me. I could have used an oil furnace, gas furnace, space heaters, wood burning stove, hot water, steam or electric. I eliminated the units that necessitated the use of water; the reason being that the well supplying the barn areas was not in operation throughout the year. Either gas-fired or electric space heaters would have worked, but considering the size of the working area, I did not want to take up any more room than necessary.

A wood stove would have been romantic and by far the cheapest, considering one can attain total utilization of material. The problem is that someone has to be there to feed the fire all the time. I have seen the wood stove used for supplemental heat during working hours, but again, I could not afford the space necessary for it.

Electric baseboards are easy to install but extremely expensive to operate.

This left me with either the oil or the gas-fired furnaces. I would have chosen the gas if it had been piped in. This was not the case and meant that

propane would have to be used. It was hard to compute but at the time, propane would have been more expensive from both the installation and the operational points of view.

A deal was then negotiated to purchase an oil-fired furnace from a local heating company. This company sold both heating equipment and fuel oil. I shopped around and found that if I purchased the furnace from them and, also, purchased fuel for the house and the shop, I could have the equipment for 10 per cent over cost--this included one service call. I did not have that much self-confidence in my installation to turn the furnace on without having it checked first. This meant that the tank, furnace, duct work, thermostat and electrical feed would have to be installed. None of these were difficult but were time consuming.

The furnace was placed in the small utility room. The heating dealer advised that the "codes" would not allow an oil supply less than ten feet from the furnace in the same room, and so, the tank was placed outside the utility room. I was hesitant about this because of reports regarding condensation and freezing in the oil line. When asked about this, the heating men told me about a snorkel type combination floating fuel pickup and gauge. This unit enables the fuel to

be drawn off the top of the tank, instead of the bottom where the water collects. The unit seems to work and is a bolt-on accessory. The oil line is simple to install; the only tools used were two crescent wrenches, a hacksaw and a flaring tool.

The electrical feed is equally simple. The furnaces are all 115 volt, low amperage units that should have a circuit of their own. The thermostat is a low voltage, 24 volt circuit requiring only lamp cord to install. I located the thermostat in the middle of the room two inches from the ceiling. This causes minor mental adjustment considering that with the warm air rising, the thermometer on the thermostat may read 70 degrees when it is, actually, 60 degrees at your ankles. All you have to do is set it a little higher.

Connecting the furnace to the chimney was no problem. It requires a reducer due to the incompatibility of the chimney to furnace outlet sizes. I purchased this at a heating supply store.

The only thing left was the duct work, which simply consisted of the hot air duct and the cold air return.

The hot air system is, actually, the plenum plus the duct or ducts. The plenum is the galvanized sheet metal box that acts as the distribution point for the

hot air ducts. These come in various sizes and shapes, according to the outlet on the furnace. The plenum, as it comes from the supply house, contains no holes for the ducts. I sat the plenum on the furnace and determined the direction that was necessary for the duct, took it off and cut a hole in it slightly (1/8 inch) smaller than the duct. I used my sabre saw, but tin snips would work. The direction of the duct was roughly determined by realizing that if the duct entered the room at 90 degrees, a shaft of hot air would be formed resulting in hot and cold areas. Actually, all that I did was stand with my back to the wall and looked at the opposite corner of the shop, thus, making the duct slope down and towards the center of the room. The duct came in 24 inch lengths making it fairly easy to handle alone with the use of a "T" made from 2x4's.

I, then, cut a hole in the wall, again, with my sabre saw, and forced the duct through it. Because of the distance (seven feet) between the plenum and the wall, a fire hazard was not created by the duct being in contact with the wall. The sheet metal never gets hot enough to be a problem. The use of either sheet metal or pop rivets can be used to fasten the duct work together.

The final step in the furnace installation was

the cold air return system. I did have some problems with this. Initially, I cut a hole in the wall, approximately three feet below the hot air inlet. I formulated that the opening in the wall should be the size of the filter supplied by the manufacturer. I had talked with the salesman and through him decided that because the utility room was so small, a cold air duct was not needed--just a hole in the wall with a filter covering it. I did not want to use a duct because it would have occupied the total floor space. Although I kept faintly smelling oil, this did work for about two weeks.

And, then, one 20 degree night I was gluing some wood. When I finished, I noticed that it was cold in the room--50 degrees on the inaccurate thermometer. The furnace would not go on, and it was supposed to go down to zero that night. After checking the circuit breaker, I immediately thought that the fuel line had frozen and proceeded to pour teakettles full of hot water on the oil line. At 11:00 P.M. when this did not accomplish anything, I called the oil company's service department. By 2:30 A.M. (35 degrees inside), I had positioned the hot plate and every portable light I could find on the gluing job, trying to nurse the setup along. Finally, the serviceman showed. He found that the exhaust gases were returning to the fire chamber and had

covered a photoelectric flame censor with carbon. I asked him why this was happening, and he repied, "Hole in the wall's too small. Either make the hole bigger or put in a duct." He told me to leave the door open and that would temporarily relieve the situation. He demonstrated that the furnace needed more air by opening the outside door and telling me to hold my hand near the propped open peep hole. When he closed the door, a five inch orange flame shot out of the hole and smartly burned every hair off my hand--to the cuff. I swore, he smiled warmly and said, "See what I mean?"

Well, the hair has grown back, I do not smell oil any more, and the furnace has stayed on all winter--all due to doubling the size of the cold air return.

PART II. EQUIPMENT

CHAPTER V

HAND TOOLS

Directly related to the type of work I thought I would be doing in the shop, was the type of equipment necessary. If I were to be doing a considerable amount of veneering, I would need a veneer press, or if I were doing much stacked furniture, I would need an electric chain saw.

The direction that I have taken seems not to be tied to one process. An individual piece might contain many methods of construction. For this reason, it became apparent that either an extensive amount of equipment was required, or I have to be familiar with a basic core of equipment and be able to improvise.

With this in mind, I here list the tools that I have purchased over the past five years. Tool catalogs are available from the suppliers. Someone will feel that the list is extravagant in places, and some will feel that it is lacking in places. I can only think of two or three small tools that are not serving me well. I have divided the tools into basic categories and have made comments when I felt that some explanation

was necessary. Where tools are not easily available, I have also provided the name of the supplier. His address is listed at the end of the tools in this chapter.

May I preface this with the recommendation to start procuring tools one at a time and using them. In this fashion the investment, the inventory, and the experience build together, the latter taking the edge off of the expense.

Set of 6 Marples, wood handled butt chisels 1/4" through 1"--Woodcraft Supply Corp.
(These are no longer available with wood handles.)

3 Eskilstuna butt chisels 1/8", 1 1/4", 1 1/2"--George Gordon
(I purchased these because Marples could not supply them.)

Stanley jointer plane--local

Stanley smooth plane--local

Stanley jack plane--local

2 Stanley block planes--local
(One used for rough treatment and one kept sharp.)

1 Stanley 90 bull nose, rabbiting plane--Woodcraft Supply Corp.

1 Stanley brad awl--local

1 Stanley scratch awl--local

2 Stanley bevels 1-8", 1-6"--local

1 Stanley brace--local
(So far, this was a waste of money.)

1 Kuntz cabinet scraper--George Gordon

2 Sanduik scraper blades--George Gordon
(I use one on the lathe and one at the bench.)

1 Sanduik swan neck scraper blade--George Gordon
(Also manufactured, is a goose neck scraper which has different curves--Woodcraft Supply Corp.)

1 Kuntz stroke burnisher (tapered triangular)--
George Gordon

1 Starrett combination square with grooved blade--
local

1 Stanley framing square--local

1 Stanley "heavy duty" hand drill--local
(I have used this more than the brace, but not much.)

3 try squares--local
1--Stanley 12"
1--Stanley 8"
1--Starrett 4"

2 Stanley jobmaster hammers--local
1--16 oz.
1--7 oz.

1 brass magnetic tack hammer--local

1 set of 5 Marples cabinetmakers delux screwdrivers--
Woodcraft Supply Corp.

1 set of 3 Sloyd knives--Woodcraft Supply Corp.

1 set of 3 brass spokeshaves--Woodcraft Supply Corp.

4 Kuntz spokeshaves--George Gordon
(I have modified the shape of the handle and blade on three of these.)

2 Stanley file type surforms with 1/2 lb. blades--
local
(I have found that when shaping wood, it is handy to have a surform with the blade for a pushing action and a surform with a pulling action.)

2 Stanley round file type surforms--local

2 Stanley marking gauges

many assorted files--local

Nickolsen file card--local

1 bear crystolon sharpening stone--local

1 bear Arkansas sharpening stone--local

assorted dividers and calipers--local
(I have sharpened the point on one end of a set of dividers--this set is used to cut out sanding discs from 9x11" sheets.)

1 Kuntz dovetail saw--George Gordon

1 Kuntz offset dovetail saw--George Gordon

1 Kuntz veneer saw--George Gordon

1 Disston back saw--local

1 Disston hand saw--local

1 Kuntz trammel points--George Gordon

1 Kuntz square glue scraper--George Gordon

1 Starrett English pattern steel rule 24"--local

1 Lufkin #60 24" rule--local
(This is thin and so very flexible enabling you to use it to lay out gentle curves.)

1 Starrett drill and steel wire gauge--local

1 Fairgate 60" aluminum rule--local

1 set of 6 Marples carving tools--Woodcraft Supply Corp.

4 large carving gouges--George Gordon

1 Pulmosan C.M.A. respirator--local

1 hacksaw--local

1 Bernzomatic Propane "Jet Torch Set"--local
(This is the simple 12" high torch that I use to remove sanding discs and melt stick shellac.)

1 Arrow T50 stapler

Clamps--Wetzler Clamp Co., Inc.
10--style #57 4 foot pipe clamps
2--B2-20 band clamps

4--R12 hand screws
6--208W Quick A tion clamps
12--204W Quick Action clamps
12--408W Quick Action clamps
24--418W Quick Action clamps
12--730W Quick Action clamps
(Some explanation is necessary to understand the clamp stock numbers. For example; the 408W clamp has a 4 inch jaw depth and opens to a length of 8 inches. The "W" on the end is the designation for a wooden handle.)

an extensive amount of mechanics tools as well as a good assortment of electrical tools

List of Suppliers

Local--designates a local supplier usually a mill supply store or good hardware store

George Gordon
c/o Three Crowns
3850 Monroe Avenue
Pittsford, New York 14534

Woodcraft Supply Corp.
313 Montvale Avenue
Woburn, Massachusetts 01801

Wetzler Clamp Co., Inc.
43-15 11th Street
Long Island City, New York 11101

There are a number of auxiliary items which might be mentioned. Here might be as good a place as any.

A good first aid kit is essential. This requires no explanation. It should be mentioned that most kits do not contain a tourniquet. It is dismal to think about, but for obvious reasons, a tourniquet should be stored in an easily reached place.

Another item is water. If you do not have any piped in water, it is a good idea to have, at least,

one quart on hand to use as an eye bath. It would be hard for me to walk to the house with lacquer thinner or Watco in my eyes, not to mention a wood chip that got past my safety glasses.

Used fire extinguishers can be purchased, and checked by a safety equipment company.

A telephone, aside from the convenience and business aspects is, probably, the most essential safety device I have. You can always call someone. I had my phone installed as an extension. This took some fancy foot work, but the local phone company, finally, agreed to it. They will install an extension anywhere, as long as it is on the same property. If you call the operator and ask her to ring the number back for an extension, she will tell you to hang up, and she will ring back in about five seconds. The telephone installer told me about this; so, it does seem acceptable to them.

CHAPTER VI

PORTABLE ELECTRICAL TOOLS

About the same time I started buying hand tools, I realized that I could use some portable power tools as well. The chronological order of the purchases was derived from the lack of the tool necessary for a given job. A good reference for basic information concerning portable electrical tools is Power Tool Maintenance by Daniel Irvin.

Rockwell Model 386R--3/8" Fastner Drill Variable Speed--Reversible

(By far this is the most used portable tool I have. It has saved me uncountless hours of time, being able to use it as a screwdriver/screw remover.)

Rockwell Model 548--Bayonet Saw

(I would give this tool an A-1 rating, having used it both in the setup of the shop and for four years in furniture construction. Not having any stationary power tools in operation at the time, I did, practically, everything imaginable in the shop renovation.)

Rockwell Model 547M--Router Motor

(This has performed flawlessly through five years of abusive ball milling and routing. There

are two optional bases for the motor; the 5378 with a "D" type handle and the 5478 with the standard dual knobs.)

(I use the "D" handled base for almost all portable routing. I, originally, mounted the other base in a one inch by three inch piece of formica covered chipboard. I am, now, in the process of making a formica covered table extension for my table saw. It would be mounted between the rip fence bars at saw table height. This will enable me to use the router as a shaper, being able to facilitate the use of the rip and crosscut fences.)

Rockwell Model 505--Finishing Sander

(Before I got into the wonders of air tools, this was the best sander in the world. If an air compressor is not available, I would strongly recommend this sander again. I have not yet had any trouble with it.)

Rockwell Model 167A--Power Block Plane

(This is the only portable power tool that I have yet to use enough to warrant purchasing. At the time of procurement, I was doing a considerable amount of large carving. With this tool, I found that I could not remove as much wood as I could with a ball mill. Now, I am in the process of making a mounting for it on the table saw to use as a plywood end grain jointer. This should perform well, as I bought it

with the optional spiral shaped carbide cutter head.)

CHAPTER VII

PORTABLE AIR TOOLS

Through my work with Wendell Castle, I was fully introduced to the utilization of portable air tools.

Because of the simplicity of construction inherent in these tools, they are, virtually, maintenance free. They are light and less expensive than their electrical counterparts. (I will go into air requirement details in a later chapter.) As most people are not familiar with the use of these tools, I will give a brief description of their use.

Ingersoll-Rand, Size 001, Multi-vane Grinder

(This tool is used for ball mill carving. The carving cutter is manufactured by Severance Tool Co. These cutters come in a variety of shapes and sizes. Any ball mill cutter will fit in the 1/4 inch collet of the grinder; but, I have found that the one inch diameter double cut ball mill removes the most wood. I have, also, discovered that the ball mills without double cut will leave a smoother finish. The "midget" ball mills (3/8 inch ball diameter) will leave a smooth close gouged texture as the grinder operates at a free air speed of 25,000 R.P.M.)

Sioux, Number 1238L, Air Sander and Polisher

(Sioux manufactures this tool with a number of R.P.M. options. This particular model is right in the middle of the speed ranges; a free air speed of 3,000 R.P.M. I have had the experience of working with three different speeds of sanders. The 6,000 R.P.M. model is good only for heavy duty, 16 and 36 grit, sanding. The 1,000 R.P.M. model is good for 80 to 220 grit sanding.)

EQUIPMENT AIR REQUIREMENT AVERAGES

Always use free air (CFM) and pressure (PSI) specifications from nameplate on the device, or from the manufacturer. CFM free air figures below are averages and should not be considered accurate for any specific brand.

Air at 80 PSI or Less

Device	Free Air CFM
Paint Spray Gun	5-10

Air at 80 to 125 PSI

Body Polisher	2-4
Body Sander	5-8
Die Grinder	1-3
Drill 1/16 to 5/8"	4-7

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CHAPTER VIII

STATIONARY POWER TOOLS

In my case, I have purchased a combination of both new and used stationary equipment. There are both advantages and disadvantages to purchasing either new or used tools. In procuring new tools, one ordinarily deals with a local dealer who can supply both parts and information regarding the new equipment. I will cover the pros and cons of used equipment later in this chapter.

In a following chapter I will also discuss the electrical requirements and installation procedures.

Below are listed the machines, along with pertinent notes concerning them.

NEW EQUIPMENT

Rockwell, Model 28-340, 20" Band Saw

(This band saw has some features that are not available on the old style. It is contained in an industrial designers cabinet with a better switch positioning.)

(The saw is, actually called a "20" wood non-ferrous cutting band saw." This two-fold function is accomplished by the utilization of a two-grooved

pulley on the motor and a step pulley on the lower wheel. To change speeds the operator changes the belts, thus, with the 1725 R.P.M. motor deriving a cutting speed of 4,500 feet per minute for wood or 2,000 feet per minute for non-ferrous cutting.)

(I have used this feature, on occasion, and it works well. This feature is not an option. This is the only Rockwell 20" wood band saw.)

(The saw has the same blade guides as on the ferrous metal cutting band saw, that is, the add-a-tab remove-a-tab system. When working in a group situation, I found this to be a great deal of trouble. In my own shop, however, I have found this to be an adequate system.)

(As with all tools, when used by only one or two people, as opposed to thirty or forty, things last longer. The tracking does not constantly need adjustment, as well as blade guides. To conform to O.S.H.A. (Occupational Safety and Health Administration) standards a new blade guard was initiated. It is a telescoping square tube that has to be removed when changing blades. If it gets to be a problem, the old style can be fabricated and installed in the same mounts.)

(Although the band saw comes with the complete tilting table setup, Rockwell does not supply or even list a part number for the handles. These can

easily be fabricated to replace the nuts supplied.)

(If one is operating with limited finances, I would recommend the purchase of a band saw previous to a table saw because of the band saws versatility. Due to the fact that I was working with, now, non-existent funds, I did purchase the band saw first and with it the rip fence and miter gauge. I would not recommend the miter guage, as I have only used it three or four times.)

Rockwell 12-14" Tilting Arbor Saw

(Because of previous experiences with this model saw, I did not hesitate purchasing one. It is more than adequate.)

(There are only two comments regarding the saw. As I understand it, in order to accommodate O.S.H.A., Rockwell was forced to include what they call the "Super-Safe" swing type blade guard and a low voltage power switch. The blade guard is a cage that pivots over the blade. I tried to order the saw without the guard but had to accept it. I never took it out of the box. The low voltage power switch is a good idea. The only problem is that it contains a transformer that hums constantly. If there is any other noise such as a radio, teakettle, etc., the hum cannot be heard. Because my circuit breaker box is quite handy to the saw, I leave the circuit

breaker off, except, of course, when the saw is in use.)

Dayton 24" Venturi-frame Exhaust Fan Kit

(I have been waiting for warm weather to install this two-speed fan and shutter assembly. It will be mounted in the window casing furthest from the furnace cold air intake. I will, also, fabricate a plywood door to either slide or swing in place to further seal the opening when the fan is not in use.)

7" Tool Grinder

(I assembled this tool from parts purchased through the W. W. Grainger, Inc. catalog. I, then, mounted this assembly and fabricated three wooden tool rests (lathe tools, plane irons, chisels). I have mounted the grinder adjacent to my lathe and have installed a foot switch for ease of intermittent operation.) A list of the parts I used are shown below.

2 shaft capacitor motor
1/2 horsepower, 1725 R.P.M., 115 volt

2 motor shaft arbors
1 left-hand thread, 1 right-hand thread

2 bronze bushings
(used to reduce the hole diameter to the arbor shaft diameter)

1 7" aluminum-oxide vitrified grinding wheel
medium (60) grit

1 7" aluminum-oxide vitrified grinding wheel
coarse (36) grit

USED EQUIPMENT

There are two methods of purchasing used equipment; the first being auctions. I have been to many auctions that have been advertised both in the newspaper and through auctioneers notifications.

I was quite nervous about the first auction I attended. I anticipated hoards of greasy old men smoking cigars ready to hustle all the cash from your pocket. The other fear was not being able to function well as a bidder. I thought the auctioneer would be talking so fast that I could not understand him and finding myself buying a conduit threading machine for $4,000 by mistake. The first part is partially true. Greasy old men there are, but there are, also, New York City dressed machinery dealers as well as many people like me.

There should be no fear concerning the actual bidding, unless the item you are bidding is first on the schedule. If it is not, you will have plenty of time to get used to the procedure. Generally, you will find that if the auction you are attending has a machine you are interested in, you will not end up taking it home with you. Either the bidding will go too high, or you will find in the pre-auction examination that there is something wrong with it. I have concluded that unless you have an excess of

free time, auctions are not worth attending. One ends up buying something. However, it is ordinarily junk that one supposes one may utilize sometime but have no definite need for it now.

The second method of purchasing used equipment is simply to buy it either from an individual, a business, or a used equipment company. There are used equipment dealers locally, but the biggest and best are in the major cities. They usually have large inventories and sell only guaranteed refitted machines. Although I have never purchased a machine from one of these dealers, I have had very good recommendations about them. The names and addresses of these firms can be found in the woodworking trade magazines.

Used equipment does offer the advantage of buying machines that one could not ordinarily afford. But one needs time to buy and rejuvenate them.

I will list the used equipment giving the method of purchase and, also giving a description of the things necessary to make the equipment operational.

Powermatic Model 45, 12" Lathe

(I purchased this five years ago from a friend who needed some money. It has given me no trouble. I have, however, had difficulty purchasing accessories. When I needed some face plates and tool rests, I called the regional distributor long distance. The manager

assured me that I would have the items in 7-10 days after receipt of my check. After three months, I have only 90 per cent of the order. In a later correspondence, he forwarded a copy of his order to the factory in Tennessee. It showed that he did, in fact, send the order out the day after my payment. The Powermatic parts department has convinced me that I am glad that I only own a Powermatic lathe.)

Yates American 12" Jointer

(I purchased this machine at an auction. I believe it was manufactured in the 1920's. When I picked it up, the machine was in need of a visual pickup. I cleaned the table surfaces with naval jelly and rubbing compound. I, then, disassembled it to check for worn parts; while it was apart, I painted everything.)

(Because the machine was originally three-phase and I had single-phase power, I had to change the motor. This I purchased from a local electric motor dealer. The machine was originally flat belt drive, and I, for convenience, wanted to change it to a 3 "V" belt system. To do this I had to buy the pulleys for both the motor and the cutter head. Pulley is the wrong word; what I needed were three-grooved cast iron sheaves and malleable split-tapered bushings. A combination of these two items forms what I call a pulley.

The bushing adapts the motor shaft to the sheave. This is done to facilitate the interchangeable parts system.)

(When I went to replace the cutter head pulley, I found that the cutter head had a taper on the drive end. I, also, found that tapered split-bushings were no longer available and that I would have to have the cutter head machined into a straight shank with a key way. I had this done and after changing the magnetic starter, I could not get the necessary parts for the old one; the jointer has performed as it did in 1930.)

Kellogg Air Compressor

(I purchased this from an individual who, originally, obtained it years ago and never hooked it up. It needed all of the electrical parts as listed on the following page. It was manufactured around 1937, thus, making details hard to obtain. I have, also, generalized about other system parts needed for installation.)

(Enclosed (page 47) is a glossary and some other information that I found extremely helpful in my setup. This information is, as I have noted on the pages, reprinted from a W. W. Grainger, Inc. catalog. This, is as well as the electrical motor glossary on page 43, the most concise grouping of specific information. The reason I am reprinting them is that one has to

have a wholesale account with Grainger's to obtain a copy of the catalog.)

5 horsepower motor

magnetic starter

pressure switch control

hoses and fittings

3/4" galvanized pipe

ELECTRIC MOTOR TERMINOLOGY

This is a glossary reprinted from a W. W. Grainger, Inc. catalog.

Ambient (Amb), the temperature of the space around the motor. Most motors are designed to operate in an ambient not over 40°C (104°F). Note: A rating of 40°C Ambient is not the same as a rating of 40°C Rise; see Temp. Rise, below.

Air-Over, motors intended for fan and blower service. Must be located in the air stream to provide motor cooling.

Enclosure (Encl), the motor's housing. Types:
- Dripproof (DP), ventilation openings in the shields and shell placed so drops of liquid falling within an angle of 15° from vertical will not affect performance. Usually used indoors, in fairly clean locations.
- Totally Enclosed (TE), no openings in the motor housing (but not airtight). Used in locations which are dirty, damp, oily, etc.
  - Totally Enclosed, Fan-Cooled (TEFC), includes an external fan, in a protective shroud, to blow cooling air over the motor.
  - Totally Enclosed, Non-Ventilated (TENV), not equipped with an external cooling fan. Depends on convection air for cooling, or on air flow from driven device (air-over).
  - Explosion-Proof (EX PRF), a totally enclosed motor designed to withstand an internal explosion of specified gases or vapors, and not allow the internal flame or explosion to escape. See p. 67 for explosive atmosphere classifications.

Full-Load Amps (F/L Amps), line current (amperage) drawn by a motor when operating at rated load and voltage. Shown on motor nameplate. Important for proper wire size selection and motor starter heater selection.

Frame, usually refers to the NEMA system of standardized motor mounting dimensions, which facilitates replacement. See facing page.

Bearings (Brgs), basic types:
- Sleeve (Slv), preferred where low noise level is important, as on fan and blower motors. Unless otherwise stated, sleeve bearing motors listed herein can be mounted in any position, including shaft-up or shaft-down (all-position mounting).
- Ball, used where higher load capacity is required or periodic lubrication is impractical. Two means used to keep out dirt:
  - Shields, metal rings with close running clearance on one side (single-shielded) or both sides (double-shielded) of bearing.
  - Seals, similar to shields, except have rubber lips that press against inner race, more effectively excluding dirt, etc.

Hertz (Hz), frequency, in cycles per second, of AC power; usually 60 Hz in USA, 50 Hz overseas. (Abbreviated Cps or Cy in the past.)

Insulation (Ins), in motors, usually classified by maximum allowable operating temperatures: Class A-105°C (221°F), Class B-130°C (266°F), Class F-155°C (311°F), Class H-180°C (356°F)

Motor Types, classified by operating characteristics and/or type of power required;
Motors for Single Phase AC Operation:
- Induction, most common type. Speed remains relatively constant as load changes. There are several kinds of induction motors:
  - Shaded pole, low starting torque, low cost. Usually used in direct-drive fans and blowers, and in small gearmotors.
  - Permanent split capacitor (PSC), performance and applications similar to shaded pole but more efficient, with lower line current and higher horsepower capabilities.
  - Split-phase start, induction run (or simply split phase), moderate starting torque, high breakdown torque. Used on easy-starting equipment, such as belt-driven fans and blowers, grinders, centrifugal pumps, etc.
  - Capacitor-start, induction-run (or simply, capacitor start or capacitor), high starting and break-down torque, medium starting current. Used on hard-starting applications; compressors, positive displ. pumps, farm equipt., etc.
  - Capacitor-start, capacitor-run, performance and applications similar to capacitor-start, induction-run, except have higher

efficiency. Generally used in higher single phase HP ratings.

Three Phase, operate on 3-phase power only. High starting and breakdown torque, high efficiency, medium starting current, simple, rugged design, long life. For all types of industrial uses.

Direct Current (DC), usable only if DC available. Special-purpose applications.

AC/DC (AC series or universal), operate on AC (60 or 50 Hz) or DC power. High speed, usually 5000 RPM or more. Brush type. Speed drops rapidly as load increases. Useful for drills, saws, etc., where high output and small size are desired and speed characteristic and limited life (primarily of brushes) is acceptable.

Mounting (Mtg), basic types:

Rigid, motor solidly fastened to equipment through metal base that is bolted or welded to motor shell.

Resilient (Res), sometimes called rubber or rbr., motor shell isolated from base by vibration-absorbing material, such as rubber rings on the end shields, to reduce transmission of vibration to the driven equipment.

Face or flange, shaft end has a flat mounting surface, machined to standard dimensions, with holes to allow easy, secure mounting to driven equipment. Commonly used on jet pumps, oil burners and gear reducers.

Stud, motor has bolts extending from front or rear, by which it is mounted. Often used on small, direct drive fans and blowers.

Yoke, tabs or ears are welded to motor shell, to allow bolting to a fan column or bracket. Used on fan-duty motors.

Rotation (Rot), direction in which shaft rotates: CW= clockwise; CCW=counterclockwise; Rev=reversible, rotation can be changed. Unless stated otherwise, rotation specified in this catalog is as viewed facing shaft end of motor.

Service factor (SF, Svc Fctr), a measure of the reserve margin built into a motor. Motors rated over 1.0 SF have more than normal margin, and are used where unusual conditions such as occasional high or low voltage, momentary overloads, etc. are likely to occur.

Temperature Rise, the amount by which a motor, operating under rated conditions, is hotter than its surroundings.

Increasingly, manufacturers are replacing the Rise rating on the motor nameplate with a listing of the Ambient temp. rating, insulation class and service factor.

Thermal Protector, a temperature sensing device built into the motor, that disconnects the motor from its power source if the temperature becomes excessive for any reason. Basic types:
Automatic-Reset (Auto), after motor cools, protector automatically restores power. Should not be used where unexpected restarting would be hazardous.
Manual-Reset (Man), an external button must be pushed to restore power to motor. Preferred where unexpected restarting would be hazardous, as on saws, conveyors, compressors, etc.
Convertible (Conv), factory-delivered as automatic-reset. Field-convertible to manual-reset.

Torque, twist, or turning ability, as applied to a shaft. Measured in foot-pounds (ft-lbs), inch-pounds (in-lbs), ounce-feet (oz-ft) or ounce-inches (oz-in). In a motor, two torque values are important:
Locked rotor torque, or starting torque, the torque produced at initial start.
Breakdown torque, the maximum torque a motor will produce while running, without an abrupt drop in speed and power.

COMPRESSED AIR SYSTEM TERMINOLOGY

This is a glossary reprinted from a W. W. Grainger, Inc. catalog.

CFM, Cubic Ft. per Min. A measure of a compressor's capacity, and of the air flow requirement of air-driven devices. Compressors have two ratings; displacement CFM and Free Air CFM; Air-driven devices are rated in Free Air CFM.
Displacement CFM is calculated by multiplying the volume of the pump cylinder(s) (low-pressure cylinders only on two-stage pumps) by the pump speed in RPM. This rating does not consider the efficiency of the air pump.
Free Air CFM is the actual air delivery of a compressor, as measured when discharged to atmospheric pressure.

Pressure (PSI), The force exerted by the compressed air, measured in lbs. per square inch (PSI).

Air Pump (Compressor Head), The part of the compressor that compresses the air.
Single Stage type, for applications requiring air at 125 PSI or less. Has one or more cylinders, all discharging directly into the tank.
Two Stage type, for applications requiring air at over 125 PSI. Has two or more cylinders, in series. The first cylinder compresses air into the second cylinder, which compresses it further and then pumps it into the tank.

Intercooler, A length of tubing, often with fins, connecting the low and high pressure cylinders of a two-stage compressor pump. It is used to dissipate some of the heat generated in compression, improving pump performance and life.

Intake Filter, A foam pad or other filtering material mounted on the pump air intake, to prevent airborne contaminants from entering the pump and reducing piston and cylinder life. Must be serviced regularly for max. pump efficiency.

Air Tank (Receiver), Stores air compressed by pump for peak loads or intermittent use. Isolates pump pressure pulsation. Two types are available:

ASME (Code) tanks are made and inspected to meet standards of the American Society of Mechanical Engineers. An ASME Certificate of Inspection is included with each tank listing registered serial number and certifying that tank has been inspected by an independent agency in accordance with ASME standards. The ASME certificate is required by law in many cities and states to pass safety codes--and is your assurance that: (1) Code approved materials are used, (2) Steel plate is without defects and is the specified thickness, (3) Proper welding techniques are employed by experienced operators, (4) Openings and supports are the correct size, and (5) Tank has passed rigid tests. (Note: Reducing nipples are not allowed on ASME tanks.) ASME tanks must be used where OSHA compliance is required.

Non-Code tanks do not meet ASME standards. Widely used on small compressors, in locations where compliance with OSHA and similar standards is not required.

Tank Pressure Controls, two types used:

Pressure Switch Control starts and stops the compressor as pressure falls and rises in the tank. Generally used on compressors for intermittent duty and where maximum air usage is less than 50% of the compressor's capacity.

Constant Speed Control releases (unloads) excess pressure, while compressor operates continuously. Used in applications where air usage is continuous, or maximum air usage exceeds 50% of the compressor's capacity. See Unloaders.

Check Valve, allows air to flow one way only from pump to tank. When compressor stops, this valve closes, preventing loss of air from tank.

Safety or Relief Valve vents the tank if excess pressure builds up. For safety, a relief valve must be used on all compressors.

Unloaders, There are two basic types:

Head Unloaders open the air discharge line between pump and tank, whenever the pump stops, relieving pressure, to make re-starting easier. A check valve prevents loss of air from the tank.

There are 3 types:
Centrifugal, a speed-activated valve that closes as compressor comes up to speed and opens when compressor stops.
Pressure Switch Unloader works together with pressure switch. Opens a valve to vent air whenever switch stops compressor. Closes valve when switch re-starts unit.
Combination Unloader and Check Valve (e.g. Load Genie, Nos. 4X996 to 4X999). As pump stops, valve senses lack of air flow and relieves pressure in discharge line. As pump starts, vent closes and check valve reopens.

Constant Speed Unloaders allow pump to operate unloaded (running, but not compressing air) when tank pressure reaches pre-set level. Used on continuous duty compressors. 2 types:
Pilot Valve Unloader holds pump intake valve open when pre-set pressure is reached.
Load Genie Continuous Run Unloader (No. 5X709) vents pump discharge line to the open air whenever tank pressure reaches pre-set level. Also acts as check valve.

AIR SYSTEM ACCESSORIES

Pressure Regulator, an adjustable valve used to reduce air pressure from the level in the tank to that required by the air-using equipment, and maintain it there automatically. May be installed at the tank or at the connection for the air-operated equipment.

Magnetic Starter, an electrically operated switch used to control the compressor motor and provide thermal protection for it. Often activated by the pressure switch.

Filter, a device connected into the air line to trap solid or liquid particles that can damage tools, contaminate sprays.

Lubricator, a device for constant feeding of oil mist into the air stream for lubrication of air-powered equipment or tools. Not used for spraying applications.

Automatic Drain Valve, installed at bottom of the tank; opens briefly during each pumping cycle to release moisture condensed from the air.

Belt Guard, metal or plastic shield around pump flywheel, belt and motor sheave, to prevent hands or clothing from getting caught in moving parts. Recommended for all installations.

PIPING REQUIREMENTS
FOR
AIR DISTRIBUTION SYSTEMS

(Reprinted from W. W. Grainger, Inc. catalog)

Pipe size used should be large enough to keep the pressure drop between the tank and the point of use to a minimum. All piping should slope to an accessible moisture drain point.

The main air line should not be smaller than the compressor outlet size. For long lines, sizes shown on the following page are recommended.

Outlets should be taken from the top of the main line, so that moisture will not enter.

Check all piping and fittings regularly to avoid leaks in the system. Filters, regulators and other accessories should also be properly maintained.

PIPE SIZES FOR COMPRESSED AIR LINES

Length of Pipe Lines in Feet

Air CFM	25	50	75	100	150	200	250	300
1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
3	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
5	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
10	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4
15	1/2	3/4	3/4	3/4	3/4	3/4	3/4	3/4
20	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
25	3/4	3/4	3/4	3/4	3/4	1	1	1
30	3/4	3/4	3/4	3/4	1	1	1	1
35	3/4	3/4	1	1	1	1	1	1
40	3/4	1	1	1	1	1	1	1
50	1	1	1	1	1	1	1	1
60	1	1	1	1	1 1/2	1 1/4	1 1/4	1 1/4
70	1	1	1	1	1 1/4	1 1/4	1 1/4	1 1/4
80	1 1/4	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	1 1/2
100	1 1/4	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	1 1/2

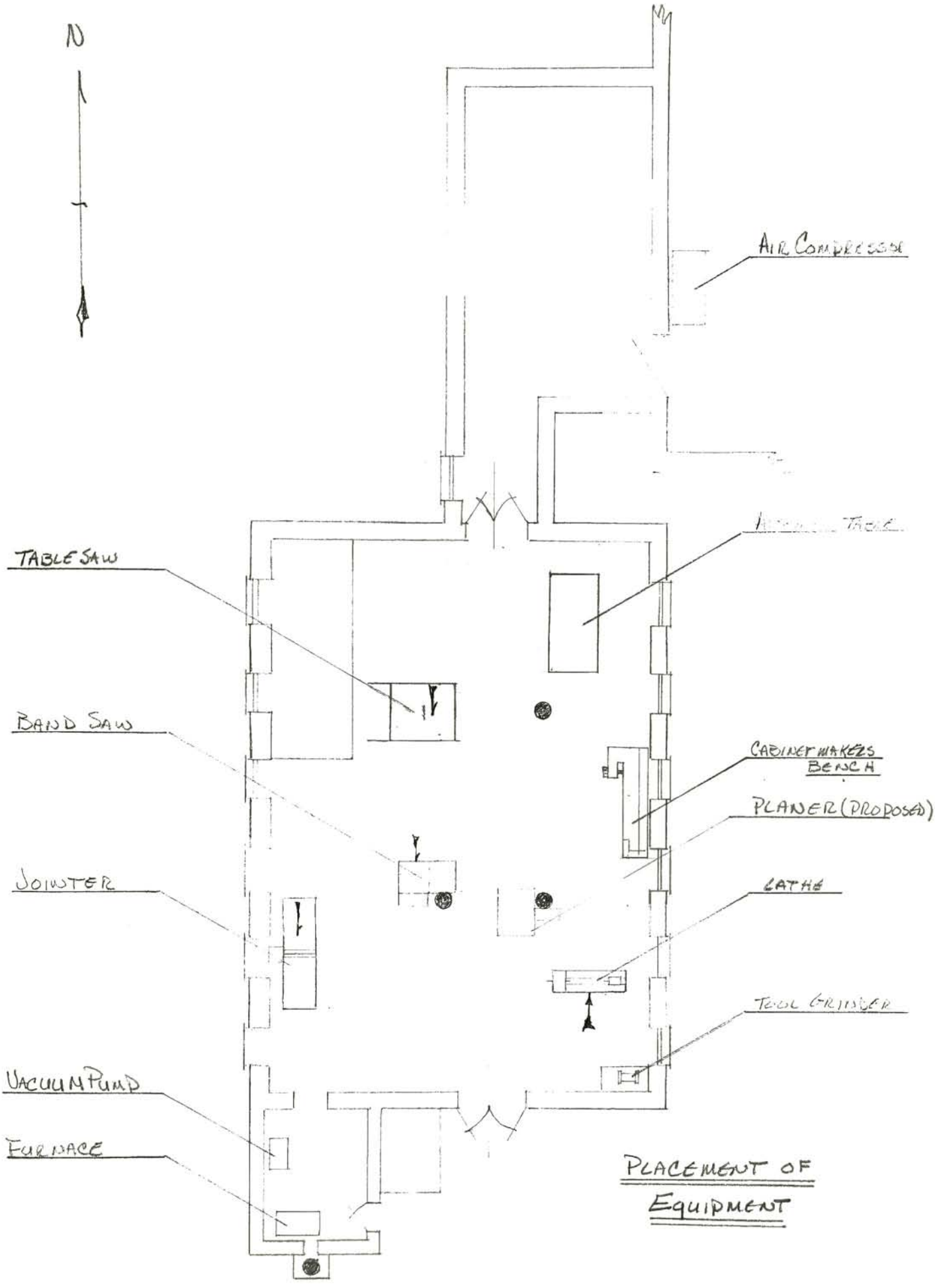
CHAPTER IX

ARRANGEMENT OF FLOOR PLAN

The most efficient placement of the equipment should be worked out on paper. This, I accomplished, by making a floor plan drawn to scale. I, then, made proportionate scale cut outs of the equipment I planned to use. By shifting the cut outs around, I could then determine what was the best working arrangement possible.

Initially, I took into account flow patterns for the material; that is, I would bring a board in through the north doors. Adjacent to the doors would be the jointer. From there the planer would be located just past and to the right of the jointer. This procedure would continue until the wood was at your bench. This system works well, if you are building a shop around the machines. As shown in the floor plan below, what I did attempt was to keep such an arrangement in mind, making sure that I could still get a 4x8 sheet through my table saw. I, also, took into account machines not yet purchased and ease of cleaning. This might not have been done to "book" specifications, but it seems to be working out satisfac-

torily. I spent a considerable amount of time shifting the cut outs around, and when satisfied, went ahead with the placement of the machines and the electrical hookup.



PLACEMENT OF EQUIPMENT

CHAPTER X

ELECTRICAL

In this section, I will take up the specifics used in wiring the shop.

To accomplish the installation of electrical power, there are two options available: 1) to have a licensed electrician come in and do the job; 2) to do it oneself. Even though I realized I probably would not select the first option, I requested an acquaintance (a licensed electrician) to give me an estimate on the total wiring installation. The installation was to be done by him, meeting the National Electrical Codes. His estimate came to $840. The cost being prohibitive, I took the second option--doing it myself.

I should admit here that I have had very little experience with construction-type wiring. I did, however, have a great deal of resources at hand. My first step was to contact a maintenance electrician employed by R.I.T. I asked if there might be a helpful manual dealing with electrical wiring. He suggested a brochure published by Sears entitled Simplified Electrical Wiring: A Handbook for Planning,

Installing, Expanding and Modernizing.

I would heartily recommend this fifty cents to anyone who has had no experience with wiring. It gives a basic knowledge of this type of electrical installation and its vocabulary. However, the reader should check its specifications against the latest codes.

My next source was a counterman at an electrical supply company. Being a slow day at the counter, we passed the time of day, discovering we had a mutual friend. At this point, I revealed to him I was not completely familiar with the ins and outs of the electrical business. He said he could tell. Then, he advised me to go home and determine the ampere ratings I would be using starting with the main power supply system. In order to help with this, he gave me a Cuttler-Hammer catalog and pointed out the page that I have enclosed below. Also appended is the Sears brochure together with a glossary reprinted from the Grainger's catalog.

With these references, plus a copy of Irvin's book, Power Tool Maintenance, I proceeded to install the wires. Noting the incongruity between the Cuttler-Hammer chart covering ampere ratings of single phase AC motors, and the chart on page 31 of the Sears book, I followed the Cuttler-Hammer ratings.

Using these factors, I determined the size of my main power line including anticipated circuits. My only departure from the codes was not to install conduit; this was due to the fact that few people frequent the barn. I do plan, however, to install conduit inasmuch as I will be storing wood in the barn, and chances of damaging the wire will be greater.

From the main line, I installed a 200 amp. circuit breaker box. I intentionally over circuited the shop, leaving 115 volt wall receptacles on two different circuits. The rational for this was that I could easily tie in medium amperage 115 volt loads without recircuiting; for example, the tool grinder and the exhaust fan.

I, also, ran a circuit for each of the 220 volt machines. I thought that if I needed to shut one down for some reason, it would not incapacitate the other.

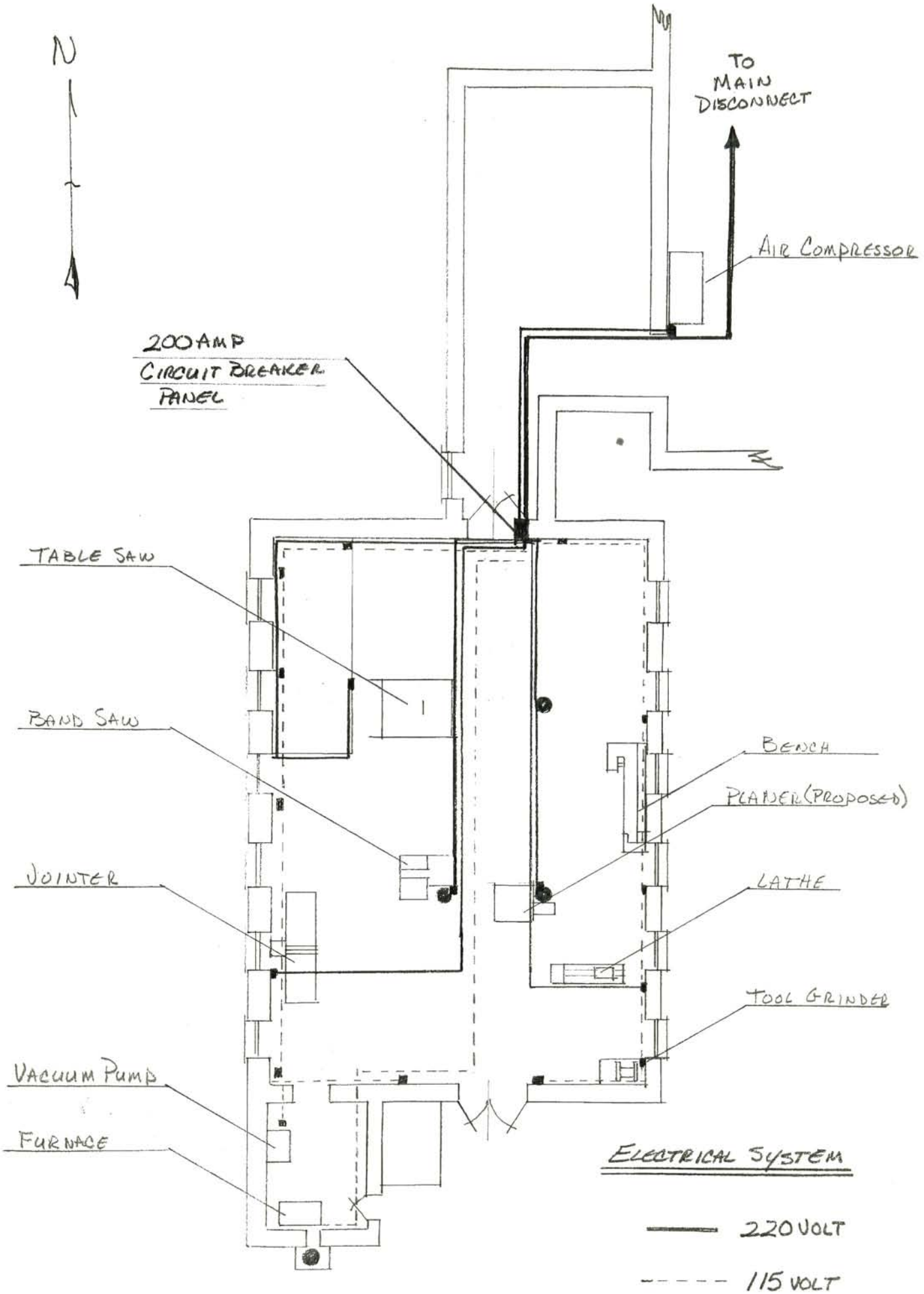
The other "over doing" involved the use of heavy gauge wires for all of 220 volt lines. I did this to facilitate the rearranging of machines. Either in the event of a new machine or a change in the original setup.

There are a few things that are handy to know, the first being that when dealing with any machinery, either mechanical or electrical, copy down all the information on the name plate. The supplier always

seems to find the question that you cannot remember; thus, necessitating either a call or driving back with the information.

The other miscellaneous items deal with nomenclature; flexible armored cable is just called "BX," plastic sheathed cable is called "Romex," and the power cord that goes from the machine to the disconnect is called "So cable." The "code" book (National Electrical Code) is available at the wholesale electrical suppliers; it is inexpensive but extremely difficult to decipher.

The following page shows the wiring diagram for the shop.


N
TO MAIN DISCONNECT
AIR COMPRESSOR
200 AMP CIRCUIT BREAKER PANEL
TABLE SAW
BAND SAW
JOINTER
VACUUM PUMP
FURNACE
BENCH
PLANER (PROPOSED)
LATHE
TOOL GRINDER
ELECTRICAL SYSTEM
220 VOLT
115 VOLT

FILE
G799

Ampere Rating of A-c and D-c Motors (continued)

AMPERE RATINGS OF SINGLE PHASE A-C MOTORS

The following table of full load current values conforms with Table 430-148 N.E. Code. Different types and makes of motors may vary considerably above or below the current values given in this table. **Selection of overload relay coils, whenever possible, should be made from actual motor current as shown on the motor nameplate or as obtained from the motor manufacturer.**

Hp	❶Full Load Current		
	115 Volts	230 Volts	
⅙	4.4	2.2	---
¼	5.8	2.9	---
⅓	7.2	3.6	---
½	9.8	4.9	---
¾	13.8	6.9	---
1	16.	8.	---
1½	20.	10.	---
2	24.	12.	---
3	34.	17.	---
5	56.	28.	---
7½	80.	40.	---
10	100.	50.	---

To obtain full-load currents of 208- and 200-volt motors, increase corresponding 230-volt motor full-load current by 10 and 15 per cent, respectively.

❶ **These values of full-load current are for motors running at usual speeds and motors with normal torque characteristics. Motors built for especially low speeds or high torques may have higher full-load currents in which case the nameplate current ratings should be used.**

AMPERE RATINGS OF THREE PHASE SYNCHRONOUS MOTORS

Hp	Assumed Efficiency	Amperes at 100% Power Factor				
		220 Volts	440 Volts	550 Volts	2200 Volts	4000 Volts
25	87.0	56	28	22.5	---	---
30	88.0	67	33.5	27	---	---
40	89.0	88	44	35	9	---
50	89.5	110	55	44	11	---
60	90.0	131	66	53	13.1	---
75	91.0	162	81	65	16.2	---
100	91.5	214	107	86	21.4	12
125	91.5	268	134	107	27	15
150	92.0	320	160	128	32	17.5
200	92.0	426	213	171	43	24
250	92.5	526	263	212	53	29
300	92.5	630	318	255	64	35
350	93.5	734	372	298	74	41
400	93.5	840	420	336	84	46
450	93.5	942	471	378	94	52
500	94.0	1045	523	418	105	58
550	94.0	1148	574	460	115	63
600	94.0	1250	625	500	125	69
650	94.5	1350	675	540	135	75
700	94.5	1450	725	580	145	80
750	94.5	1560	780	625	156	86
800	95.0	1660	830	665	166	91
900	95.0	1860	930	745	186	102
1000	95.0	2060	1030	825	206	113

Amperes given above are based on an average efficiency for given H.P. at all speeds. For instance, 25 H.P. amperes are based on 87% efficiency for all speeds and 1000 H.P. on 95% efficiency for all speeds.
For 2 Phase Amperes multiply values in table by .866.
For 80% P.F. amperes multiply 100% P.F. values by 1.29.

D-C MOTORS—AMPERE RATINGS AND FUSE SIZES

Hp	Ratings of D-c Motors		Amp. Cap. of Fuses for Motors	
	Full-Load Amperes		Recommended Values	
	120 Volts	240 Volts	120 Volts	240 Volts
⅛	1.4	.7	3	3
⅙	1.8	.9	3	3
¼	2.9	1.5	5	3
⅓	3.6	1.8	5	3
½	5.2	2.6	7	3
¾	7.4	3.7	10	5
1	9.4	4.7	15	7
1½	13.2	6.6	20	10
2	17.	8.5	25	12
3	25.	12.2	30	15
5	40.	20.	50	25
7½	58.	29.	80	40
10	76.	38	100	50
15	---	55	---	75
20	---	72	---	100
25	---	89	---	125
30	---	106	---	150
40	---	140	---	200
50	---	173	---	250
60	---	206	---	275
75	---	255	---	350
100	---	341	---	500
125	---	425	---	600
150	---	506	---	---
200	---	675	---	---

PART III. BUSINESS PRACTICES

CHAPTER XI

INITIAL STEPS IN THE FORMATION OF THE BUSINESS

While still attending undergraduate school, I found the need to open accounts with various suppliers. A plan should, probably, have been formulated, but the procedure I followed worked.

I started by opening an account with a large hardware concern with both wholesale and retail accounts. This lead to the procurement of accounts with larger wholesale firms. With these accounts came discount.

The next step was to have stationery printed with a letterhead--D. Hunter Kariher, Jr., Designer-Craftsman. It seemed more professional than corresponding on notebook paper stuffed into the wrong-sized envelope. At the same time, I opened a personal checking account using the same letterhead.

Next, I obtained a New York State Sales Tax Exemption. This item (tax number) is easily obtainable through the New York State Department of Taxation and Finance and can be done by mail.

Since starting the shop, I have decided that I should have a more professional corporate name. The new name is "Liberty Hill Woodworks"--the origin

is the location of the shop--Liberty Hill Farms.

When I went to the bank to change the checking account, they informed me that I must first go downtown and fill out an assumed name form. In two weeks, I would find out if I could use that title or if someone else in New York State was using it. I have not yet had time to do this and am still using the old checking account. The bank frowns on the use of personal checking accounts for business purposes.

CHAPTER XII

BOOKKEEPING

In this thesis, I had initially planned to provide a monetary accounting of my experiences. But, as explained earlier, this was not possible. However, in preparation to this writing, I was forced to initiate some form of record keeping. I had, fortunately, retained 90 per cent of the receipts for both tools and materials. I compiled separate files to contain all of these receipts plus the ones related to the shop setup. These expenses are recorded on a ledger sheet corresponding to a given file. The ledger sheet was duplicated, and the copy kept in another location outside the shop. The information on the ledger sheet contains the following data: date of purchase, supplier, part or stock number, serial number, price, abbreviated description of item and suppliers invoice number. Usually not all of these categories apply, but as much as is possible is recorded.

At income tax time, I invited a C.P.A. friend out to talk about taxes. He looked at my filing system and thought it was adequate. He, also, suggested

that I obtain from the Internal Revenue Service a copy of Schedule C (form 1040) and its instructions along with a copy of form 4562. The accountant advised me to use these two forms as a basis for my bookkeeping. I have enclosed these forms below. The forms can be obtained from any Internal Revenue Service office or from some post offices. Although I have not initiated any income-expense bookkeeping, I plan to use one of the systems mentioned on the Schedule C form.

SCHEDULE C (Form 1040)
Department of the Treasury
Internal Revenue Service

Profit or (Loss) From Business or Profession

(Sole Proprietorship)

► Attach to Form 1040. ► Partnerships, joint ventures, etc., must file Form 1065.

1973

Name(s) as shown on Form 1040 | Social security number

Principal business activity (see Schedule C Instructions) ►.....; product ►.....

Business name ►..... C Employer identification number ►.....

Business address (number and street) ►.....

City, State and ZIP code ►.....

Indicate method of accounting: (1) ☐ Cash (2) ☐ Accrual (3) ☐ Other ►.....

	Yes	No
Were you required to file Form W-3 or Form 1096 for 1973? (See Schedule C Instructions.)		
If "Yes," where filed ►		
Was an Employer's Quarterly Federal Tax Return, Form 941, filed for this business for any quarter in 1973?		
Method of inventory valuation ► ..... Was there any substantial change in the manner of determining quantities, costs, or valuations between the opening and closing inventories? (If "Yes," attach explanation)		

1 Gross receipts or sales $ ..... Less: returns and allowances $..... Balance ►		
2 Less: Cost of goods sold and/or operations (Schedule C–1, line 8)		
3 Gross profit		
4 Other income (attach schedule)		
5 **Total income** (add lines 3 and 4)		
6 Depreciation (explain in Schedule C–3)		
7 Taxes on business and business property (explain in Schedule C–2)		
8 Rent on business property		
9 Repairs (explain in Schedule C–2)		
10 Salaries and wages not included on line 3, Schedule C–1 (exclude any paid to yourself)		
11 Insurance		
12 Legal and professional fees		
13 Commissions		
14 Amortization (attach statement)		
15 (a) Pension and profit-sharing plans (see Schedule C Instructions)		
(b) Employee benefit programs (see Schedule C Instructions)		
16 Interest on business indebtedness		
17 Bad debts arising from sales or services		
18 Depletion		
19 Other business expenses (specify):		
(a)		
(b)		
(c)		
(d)		
(e)		
(f)		
(g)		
(h)		
(i)		
(j)		
(k) Total other business expenses (add lines 19(a) through 19(j))		
20 **Total deductions** (add lines 6 through 19)		
21 Net profit or (loss) (subtract line 20 from line 5). Enter here and on Form 1040, line 28. **ALSO** enter on Schedule SE, line 5(a)		

SCHEDULE C–1.—Cost of Goods Sold and/or Operations (See Schedule C Instructions for Line 2)

1 Inventory at beginning of year (if different from last year's closing inventory, attach explanation)		
2 Purchases $..... Less: cost of items withdrawn for personal use $..... Balance ►		
3 Cost of labor (do not include salary paid to yourself)		
4 Materials and supplies		
5 Other costs (attach schedule)		
6 Total of lines 1 through 5		
7 Less: Inventory at end of year		
8 Cost of goods sold and/or operations. Enter here and on line 2 above		

SCHEDULE C–2.—Explanation of Lines 7 and 9

Line No.	Explanation	Amount	Line No.	Explanation	Amount
		$			$

SCHEDULE C–3.—Depreciation (See Schedule C Instructions for Line 6) If you need more space, you may use Form 4562.

Note: If depreciation is computed by using the Class Life (ADR) System for assets placed in service after December 31, 1970, or the Guideline Class Life System for assets placed in service before January 1, 1971, you must file Form 4832 (Class Life (ADR) System) or Form 5006 (Guideline Class Life System). Except as otherwise expressly provided in income tax regulations sections 1.167(a)–11(b)(5)(vi) and 1.167 (a)–12, the provisions of Revenue Procedures 62–21 and 65–13 are not applicable for taxable years ending after December 31, 1970.

Check box if you made an election this taxable year to use ☐ Class Life (ADR) System and/or ☐ Guideline Class Life System.

a. Group and guideline class or description of property	b. Date acquired	c. Cost or other basis	d. Depreciation allowed or allowable in prior years	e. Method of computing depreciation	f. Life or rate	g. Depreciation for this year
1 Total additional first-year depreciation (do not include in items below) →						
2 Depreciation from Form 4832 (See Note above) *						
3 Depreciation from Form 5006 (See Note above) *						
4 Other depreciation:						
Buildings						
Furniture and fixtures						
Transportation equipment						
Machinery and other equipment						
Other (specify)						
5 Totals						
6 Less amount of depreciation claimed in Schedule C–1, page 1						
7 Balance—Enter here and on page 1, line 6						

SUMMARY OF DEPRECIATION (Other Than Additional First-Year Depreciation)

	Straight line	Declining balance	Sum of the years-digits	Units of production	Other (specify)	Total
1 Depreciation from Form 4832						
2 Depreciation from Form 5006						
3 Other						

SCHEDULE C–4.—Expense Account Information (See Schedule C Instructions for Schedule C–4)

Enter information with regard to yourself and your five highest paid employees. In determining the five highest paid employees, expense account allowances must be added to their salaries and wages. However, the information need not be submitted for any employee for whom the combined amount is less than $10,000, or for yourself if your expense account allowance plus line 21, page 1, is less than $10,000.

Name	Expense account	Salaries and Wages
Owner		
1		
2		
3		
4		
5		

Did you claim a deduction for expenses connected with:

(1) Entertainment facility (boat, resort, ranch, etc.)? ☐ Yes ☐ No (3) Employees' families at conventions or meetings? ☐ Yes ☐ No

(2) Living accommodations (except employees on business)? ☐ Yes ☐ No (4) Employee or family vacations not reported on Form W–2? ☐ Yes ☐ No

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nstructions for Schedule C (Form 1040)

If you owned a business or practiced a ·ofession, complete Schedule C. Then ıter your net profit or loss on Form 1040, ıe 28. If you had more than one busi- ess, or if you and your spouse had sepa- ıte businesses, complete a Schedule C ır each business. Farmers should use chedule F.

You have to pay the social security self- nployment tax on income from any trade · business, unless specifically excluded. ee Schedule SE. Generally, if you filed orm 4029 or Form 4361, do not file chedule SE. Instead write "Exempt— orm 4029" or "Exempt—Form 4361" on ne 55 of Form 1040.

If some of your expenses are part busi- ess and part personal, you can deduct ıe business part but not the personal art. For instance if only half of a busi- essman's car usage is for business, he can educt only half of the cost of operating the ar.

Sales, exchanges, or involuntary conver- ons of certain trade or business property are to be reported on Form 4797, Supplemental Schedule of Gains and Losses.

Accounting Methods and Records.—On your return you must use the "cash method" of reporting unless you kept books of account. If you kept such books, you can use either the "cash method," "accrual method," or other method, such as "completed contract" or "percentage of completion." You can use any of these methods or a combination of them, provided the method or methods used properly reflect your income.

"Cash method" means you generally show all items of taxable income actually or constructively received during the year (whether in cash, property, or services) and those amounts actually paid during the year for deductible expenses. Income is "constructively" received when it is credited to your account or set aside for you to draw on at any time.

"Accrual method" means you report income when earned, even if not received, and deduct expenses when incurred, even if not paid during the tax year.

Item A—Principal Business Activity and Product.—Give the one business activity that accounted for the largest percentage of gross income included in Schedule C, page 1, line 1. State the broad field of business activity as well as the product or service. For example, "wholesale—drugs," "retail—apparel."

Item C—Employer Identification Number.—An employer identification number is not needed unless you were required to file an excise, alcohol, tobacco, firearms, or employment tax return (other than on Form 942 or Form CT–2).

Item D—Business Address.—Do not use your home address as a business address unless you actually conducted the business from your home. Show street address rather than box number.

Item F—Information Returns.—You may be required to file information returns for wages paid to employees, certain payments of fees and other nonemployee compensation, interest, rents, royalties, annuities and pensions. For more detailed information, see instructions for Forms W–3 and 1096.

Income

Line 1—Gross receipts or gross sales.—Enter gross receipts or sales from your trade or business, except those items required to be reported in line 4. (See instructions for line 4.)

Returns and allowances.—Enter such items as returned sales, rebates, and allowances from the sale price or service charge.

Installment Sales.—If you use the installment method of reporting income from sales, attach to your return a schedule showing separately for 1973 and the three preceding years:

(1) gross sales,
(2) cost of goods sold,
(3) gross profit,
(4) percentage of gross profits to gross sales,
(5) amounts collected, and
(6) gross profits on amounts collected.

Line 2—Cost of goods sold, Schedule C–1.—If you were engaged in a trade or business in which the production, purchase, or sale of merchandise was an income producing factor, inventories of merchandise must be taken into account at the beginning and end of your tax year.

The inventories can be valued at:

(1) cost,
(2) cost or market, whichever is lower, or
(3) any other method approved by the Commissioner.

You must continue to use the same valuation method you adopted for the first year you took inventory unless you get permission to change your method by applying to the Commissioner of Internal Revenue, Washington, D.C. 20224. Use Form 3115 to apply for permission to change your method of valuing inventories. It must be filed with the Commissioner within 180 days after the beginning of the tax year in which you want to use the new method.

Cost of Operations (Where Inventories are Not an Income-determining Factor).—If the amount entered on line 2 includes an amount applicable to cost of operations, complete appropriate lines of Schedule C-1.

Line 4—Other Income.—Include on line 4 finance reserve income, sales of scrap, amounts recovered from bad debts, and interest, as well as other kinds of miscellaneous income from your trade or business.

Deductions

Note: That portion of payments willfully made in excess of Stabilization Guidelines are not deductible as a business expense under section 162(c)(2). (Revenue Ruling 72–236, 1972–1, C.B. 41.)

Line 6—Depreciation.—You can deduct a reasonable allowance for the exhaustion, wear and tear, and obsolescence of property used in a trade or business, or property held for the production of income. The allowance is not allowed for stock in trade, inventories, land, and personal assets. See **Form 4562** for information on depreciation methods, limitations and special rules.

Class Life (ADR) System and Guideline Class Life System.—If you figure depreciation by using the Class Life (ADR) System for assets put in service after December 31, 1970, or the Guideline Class Life System for assets put in service before January 1, 1971, you must file Form 4832 (Class Life (ADR) System) or Form 5006 (Guideline Class Life System). For more information, get **Publication 534,** Tax Information on Depreciation.

Line 9—Repairs.—You can deduct the cost of incidental repairs, including labor (but not the value of your own labor), supplies, and other items, that do not add to the value or appreciably prolong the life of the property. Amounts spent to restore or replace property are not deductible. They are chargeable to capital accounts or to depreciation reserve, depending on how depreciation is charged on your books. Include on line 9 the total amount of repairs from Form 4832.

Line 14—Amortization.—For the election to amortize expenditures for pollution control facilities, research or experimentation, a trademark or trade name, railroad rolling stock, railroad grading and tunnel bores, certain coal mine safety equipment, and on-the-job training and child care facilities, see Code sections 169, 174, 177, 184, 185, 187, and 188, respectively.

Line 15(a)—Retirement Plans, etc.—Enter the amount being claimed as a deduction for contributions to a pension, profit-sharing, or annuity plan.

Note: Every employer who has adopted a pension, profit-sharing, or other funded deferred compensation plan, regardless of whether or not the plan is qualified under the Internal Revenue Code or whether a deduction is claimed for the current taxable year, must file Form 4848 for all plans adopted. In general, Form 4848 is to be filed on or before the 15th day of the 5th month following the close of the taxable year. If the plan includes you as a self-employed person, enter contributions made as an employer on your behalf (but not voluntary contributions you made as an employee) on Form 1040, line 42, instead of on line 15(a) of Schedule C. (See Form 4848.)

Line 15(b)—Employee benefit program.—Enter the amount of your contributions to employee benefit programs that are not an incidental part of a pension or profit-sharing plan included on line 15(a). Contributions to employee benefit programs that are to be reported on this line include insurance, health, and welfare programs.

Line 16—Interest on Business Indebtedness.—Do not include in line 16, interest that your trade or business paid or accrued on debts incurred to purchase or carry property held for investment. (See Code section 163(d)). You should claim this interest on investment debts on Schedule A (Form 1040). For further information, see Schedule A (Form 1040) instructions.

Line 17—Bad Debts Arising from Sales or Services.—Include debts, or portions of them arising from sales or professional services that were included in income and definitely known to be worthless; or a reasonable amount that was added during the tax year to a reserve for bad debts. A debt which is deducted as bad and which reduces your tax must, if later collected, be included as income for the year in which collected.

Line 18—Depletion.—If a deduction is claimed on account of timber depletion, attach Form T to your return.

Line 19—Other Business Expenses.—Include all ordinary and necessary business expenses. Do not include cost of business equipment or furniture, amounts spent for replacements or permanent improvements to property, or personal living and family expenses.

Automobile Expenses, Special Rule.—See page 9 of Form 1040 instructions for optional method of figuring deductible automobile expenses.

Schedule C–4—Expense Account Information.—Expense account allowance means (a) amounts other than compensation, received as advances or reimbursements, and (b) amounts paid by or for you for expenses incurred by or for yourself or your employees, including all amounts charged through any type of credit card, for which a deduction is claimed in this schedule. This term does not include amounts paid for (a) the purchase of goods for resale or use in your business, and (b) incidental expenses, such as the purchase of office supplies or for local transportation in connection with an errand. You should keep records as proof of amounts spent for entertainment.

Form **4562**

Department of the Treasury
Internal Revenue Service

Depreciation

▶ See instructions.
▶ Attach this form to your return.

1973

Name(s) as shown on return | Identifying number

This form may be used as an attachment to an individual, partnership, fiduciary, or corporation return. The totals on line 5 below must be included on the corresponding lines of the regular depreciation schedule. Taxpayers must also complete the Summary of Depreciation provided on the applicable form or schedule.

a. Group and guideline class or description of property	b. Date acquired	c. Cost or other basis	d. Depreciation allowed or allowable in prior years	e. Method of computing depreciation	f. Life or rate	g. Depreciation for this year
1 Total additional first-year depreciation (do not include in items below) ▶						
2 Depreciation from Form 4832						
3 Depreciation from Form 5006						
4 Other depreciation:						
Buildings						
Furniture and fixtures						
Transportation equipment						
Machinery and other equipment						
Other (specify)						
5 Totals						

These totals should also be included on the corresponding lines of your regular depreciation schedule. (For example: If depreciation applies to Schedule F (Form 1040), include the totals on Schedule F, line 59.) Also check the Class Life (ADR) System and/or the Guideline Class Life System box(es) in the depreciation schedule of tax return if either system was elected this taxable year.

Instructions

Note: *Instructions for Class Life (ADR) System and Guideline Class Life System are contained in separate instructions for Form 4832 (Class Life (ADR) System) and on Form 5006 (Guideline Class Life System). Also see Publication 534, Tax Information on Depreciation.*

Reasonable Allowance.—You may deduct a reasonable allowance for the exhaustion, wear and tear, and obsolescence of property used in a trade or business, or of property held for the production of income. The allowance is not allowed for stock in trade, inventories, land and personal assets.

Charge off the cost (or other basis) to be recovered over the expected useful life of the property. Depreciation begins when the asset is placed in service and ends when the asset is retired from service.

In computing the basis on which depreciation may be taken for personal property other than livestock, you need not take into account salvage value that does not exceed 10 percent of the cost or other basis of the property. If the salvage value exceeds 10 percent, take only the excess into account. These provisions apply to property acquired after October 16, 1962, and having a useful life of three years or more.

Depreciation Methods.—The various methods of depreciation which may be used under section 167(b) are:

Straight Line Method.—The depreciation for each year is determined by dividing the cost or other basis of the property, by the remaining useful life of the property. The cost or other basis must be adjusted by depreciation allowed or allowable in prior years and salvage value if applicable.

Declining Balance Method.—Apply a uniform rate each year to the remaining cost or other basis of property determined at the beginning of the year, without adjustment for salvage value.

(Continued on back)

owever, depreciation must stop when ıe unrecovered cost is reduced to sal- ıge value. The rate of depreciation for sed property under this method may ot exceed 1½ times the applicable raight line rate. *Note: See "Limitation n Accelerated Depreciation for Used Sec- on 1250 (Real) Property."*

Special Rules for New Assets.—You ıay also depreciate the cost or other asis of a new asset under any of the llowing methods, provided that (a) the sset is tangible, (b) it has an estimated seful life of three years or more to the ıxpayer, and (c) the original use of the sset commenced with the taxpayer. *ote: See "Limitation on Accelerated De- reciation for New Section 1250 (Real) roperty."*

(1) Declining balance method.—Use ıis method with a rate not in excess of vice the applicable straight line rate.

(2) Sum of the years-digits method.— ompute the deduction for each year by ıultiplying the cost or other basis of ıe property (reduced by estimated sal- ıge value) by the number of years of seful life remaining (including this year), nd dividing the product by the sum of all ıe digits corresponding to the years of ıe estimated useful life of the asset. In ıe case of a 5-year life, this sum would e 15 (5 + 4 + 3 + 2 + 1). For the first ear five-fifteenths of the cost reduced by stimated salvage value would be allow- ble; for the second year, four-fifteenths, tc.

(3) Other methods.—You may use ny consistent method which does not esult at the end of any year in accu- ıulated allowances greater than the total f the accumulated allowances which ould have resulted from the use of the 00 percent declining balance method. his limitation applies only during the rst two-thirds of the property's useful fe.

Change in Method.—If you wish to hange your method of computing depre- iation, the tax treatment of salvage ecoveries on sale, exchange, or other isposition of business property, or the ax treatment of additions or retirements om multiple asset accounts, you may le Form 3115 with the Service Center here you will file your return. You must le within the first 180 days of the tax- ble year to which the change relates.

Additional First-Year Depreciation.— ou may elect to write off in the year ssets are first subject to depreciation, 0 percent of the cost of the assets (be- ore adjustment for salvage value) if they re tangible personal property (e.g., quipment, machinery, etc.) acquired by urchase for use in a trade or business to be held for the production of income. the aggregate cost of these assets ex- eeds $10,000 ($20,000 for joint return), ıe additional depreciation is limited to 2,000 ($4,000 for joint return).

The additional depreciation is limited) property with a remaining useful life f six years or more and which was not cquired from a person (other than a rother or sister) whose relationship to ıe taxpayer would result in the disallow- nce of losses. Normal depreciation may so be taken on the cost of the asset, educed by the first-year depreciation.

The total additional first-year depreci- tion for the year should be entered on ıe line provided in the depreciation chedule. Do not include on the line used) show the regular depreciation of an sset.

Limitation on Accelerated Depreciation for New Section 1250 (Real) Property.— The double declining balance and sum of the years-digits methods may not be used except for (1) new residential rental property (from which at least 80% of the gross rental income is derived from rental of residential units), (2) other new real property acquired before July 25, 1969, and (3) new real property placed in service after July 24, 1969, if construction, acquisition, or permanent financing arrangements were entered into before July 25, 1969. Other new real property acquired after July 24, 1969, may be depreciated under the straight line or 150% declining balance methods.

Limitation on Accelerated Depreciation for Used Section 1250 (Real) Property.— Used residential rental property acquired after July 24, 1969, with a useful life of 20 years or more may be depreciated under the 125% declining balance method. In the case of used real property acquired before July 25, 1969, or used real property acquired after July 24, 1969, pursuant to a written contract entered into before July 25, 1969, for the acquisition of such property or for the permanent financing thereof, depreciation is limited to the 150% declining balance method. Other used real property acquired after July 24, 1969, may be depreciated under the straight line method.

Rehabilitation Expenditures for Low-Income Rental Housing.—A taxpayer may elect to compute the depreciation deduction under section 167(k) for rehabilitation expenditures incurred for low-income rental housing under the straight line method using a useful life of 60 months and no salvage value in lieu of any other method of computing depreciation. If this election is for property held by a partnership, the partnership must make the election. (The term "low-income rental housing" means any building the dwelling units in which are held for occupancy on a rental basis by families and individuals of low or moderate income, as determined by the Secretary or his delegate in a manner consistent with the policies of the Housing and Urban Development Act of 1968.)

Limitations.—The expenditures: (1) must not exceed $15,000 per dwelling unit in the building, and (2) must exceed $3,000 per unit over a period of two consecutive taxable years. This rapid write-off does not apply to motels, hotels, or other establishments where more than one-half of the units are rented on a transient basis.

Time and Manner of Making Election.— An election under section 167(k) shall be made by attaching a statement to the income tax return filed for the first taxable year in which the taxpayer computes the depreciation deduction using a 60-month useful life. In general, this election must be filed no later than the time prescribed by law (including extensions thereof) for filing the taxpayer's return for the taxable year in which the property is placed in service (see I.T. Regs. § 1.167(k)–4).

An information statement shall be attached to the income tax return for each subsequent taxable year in which the taxpayer computes depreciation under section 167(k).

Information Required for Election Year.—

(1) Taxpayer's name, address, and identification number.

(2) Description of property with respect to which an election is made, and the date such property was placed in service.

(3) Location and description of building being rehabilitated.

(4) Number of dwelling units in the structure, and the number of such units used on a transient basis (see I.T. Regs. § 1.167(k)–3(c)(2)).

(5) Date rehabilitation expenditures are incurred (see I.T. Regs. § 1.167(k)–1(a)(2)).

(6) Statement that all income certifications required by I.T. Regs. § 1.167(k)–3(b)(4) have been obtained.

(7) For each dwelling unit which the taxpayer seeks to qualify as low-income housing for purposes of the election under section 167(k):

(a) Rehabilitation expenditures allocated to such unit (see I.T. Regs. § 1.167(k)–2(d)),

(b) For each period of occupancy during the taxable year, the number of occupants, the maximum income level permissible under I.T. Regs. § 1.167(k)–3(b)(2) for that number of occupants, the adjusted income of the occupants of such unit (determined solely from the income certifications required by I.T. Regs. § 1.167(k)–3(b)(4)), and the rent charged for such unit, and

(c) For each period in which such unit is vacant during the taxable year, a description of each such unit (as to number of rooms), the low or moderate income level in that area for the number of persons occupying comparable units, and the rental at which each vacant unit is offered.

(8) If allocation is required under I.T. Regs. § 1.167(k)–2(d), the area occupied by dwelling units and nondwelling units.

(9) If applicable, statement of intent to fulfill $3,000 minimum amount limitation (see I.T. Regs. § 1.167(k)–4(a)(2)).

(10) If the taxpayer is treated as having paid or incurred expenditures by reason of I.T. Regs. § 1.167(k)–1(b), the amount of such expenditures, the date the expenditures were incurred, the date the property attributable to the expenditures was placed in service, the method of accounting used by the person that made the expenditures, and the purchase price for the property attributable to the expenditures.

Information Required for Subsequent Years.—For each taxable year in which depreciation is computed under section 167(k) after the taxable year of the election, the statement required by this section must state the rental charges for each occupied unit and the rental charge at which each vacant unit is offered. In addition, if any such unit is rented to a new tenant during the taxable year, such statement must also contain the following information:

(1) A statement that such tenant has signed an income certification (see I.T. Regs. § 1.167(k)–3(b)(4)),

(2) The number of occupants in the unit, the maximum income level permissible under I.T. Regs. § 1.167(k)–3(b)(2) for that number of occupants, and the total adjusted income of such occupants, determined solely from the income certifications required by I.T. Regs § 1.167 (k)–3(b)(4).

Definitions.—See section 167(k) and I.T. Regs. § 1.167(k)–3 for definitions of rehabilitation expenditures, low-income rental housing, dwelling unit, low or moderate income, and adjusted income.

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CHAPTER XIII

INSURANCE

Practically all of this chapter will be concerned with ideas that I have not yet solved.

I have done an appreciable amount of research, mainly, by contacting a friend who is in the insurance business. I have known this man for many years and trust him implicitly. He owns an independent insurance agency.

An independent insurance agency is an agency not exclusively connected with one insurance company--they sell insurance supplied from many companies. This is an advantage because a good agent will "shop around" for you and find the company suited for your needs. The companies do not always supply the same services at the same rates.

Below is listed a minimum program of insurance for the woodworker, although this list does not necessarily apply to me, it is meant to give some preparation to someone in the process of shop setup. It is to be emphasized that one would find a reputable agent and talk to him regarding ones own insurance requirements and rates. The rate is the measure of

risk. When applied to a given amount of insurance, a premium is determined. The premium is the amount one pays.

Keep in mind that the insurance regulations vary from state to state, and a local agent can brief you concerning requirements in your own area.

This listing is based on New York State regulations and is presented in the insurance companies vocabulary.

WORKMENS COMPENSATION

Perils Insured: "on the job" injuries sustained by any employee

Property Insured: all employees of the business part time and full time (not including the owner of the proprietorship) including officers

Amount Insured: as required by law, all medical expenses incurred by injured employee, 2/3 average weekly wages, lump sum settlements for permanent disability

(The state publishes a book of rates for different vocations.)

The type of business I am engaged in is classified a "cabinet works with power equipment," and the rate is $2 per $100 of estimated annual payroll. This estimated payroll is subject to audit by the insurance company, and the premium is adjusted accordingly. What this means is that if you employ a helper, either full or part time, you are required by law to carry workmens

compensation insurance for him. The premium is determined by taking his estimated annual wages, say $5,200, and multiplying it by a $2 per $100 of payroll figure or the estimated premium would be $140 per year. If, when the insurance company audits the payroll accounts they find that the man had left after six months and received no raises, they would lower the premium to $70.

If the owner of a proprietorship wants to be insured for "on the job" accidents, he must either take out an accident policy on himself or become an employee of a corporation. He may own say 99 per cent of the stock of the corporation and still be an employee.

NEW YORK STATE DISABILITY BENEFITS

Perils Insured:	"off the job" injury or sickness sustained by any employee
Property Insured:	all employees of the business (excluding part-time students) including all officers
Amount Insured:	as required by law, 2/3 average weekly wages, seven day waiting period, 26 week maximum benefit period
Annual Premium:	based on estimated annual payroll with all payroll subject to $100 per week per employee maximum; premium payable to quarterly audit

FIRE INSURANCE

Perils Insured:	fire and lighting, extended coverage (windstorm, hail, explosion, riot, falling aircraft, uninsured vehicles), vandalism (optional: "all risk")

Property Insured: all contents of plant and office, including: merchandise held for sale, office furniture and fixtures at replacement cost, improvement and betterment at replacement cost while situated in the plant premises

Amount Insured: as stated by the insured

Coinsurance: 80 per cent coinsurance clause applies (amount of insurance carried must equal at least 80 per cent of full value of insured property at the time of loss to avoid penalty and collect loss in full)

The rate for the fire insurance is determined by the factors listed below. These factors, if possible, should be considered when setting up the shop.

Geographic Location: This means distance from the nearest fire hydrant and the isnsurance company's evaluation of the fire department in your area. There are four or five evaluation codes the best being a city fire department. About fourth on the list, is a volunteer fire department.

Construction of Building: frame buildings are rated the highest risk while 12" concrete block the lowest

Type of Occupancy: what will be going on inside the building--needless to say, a woodworking shop has a high risk factor

Degree of Insurance: this is the dollar amount one tells his agent that his property is worth

Another note concerning fire insurance. Along with the accountant, my agent was pleased with my bookkeeping system. One should keep fairly close records on his inventory including all materials.

The agent suggested that every time I photographed a finished piece in the shop to take a few pictures of the working space. These photographs can serve as a memory stimulating device. It makes sense to store a copy of the file or the photos in another place.

COMPREHENSIVE GENERAL LIABILITY POLICY

Perils Insured:	all claims brought by a member of the public (non-employee) alleging injury to person or damage to the property or personal injury caused by negligence
	all claims brought by member of public alleging injury to person caused by products sold and utilized elsewhere
Property Insured:	plant and office; products located anywhere in continental U.S. and Canada
Amount Insured:	(usually) $100,000 per person; $300,000 per occurrence bodily injury
	$50,000 per occurrence $50,000 aggregate property damage

CHAPTER XIV

CONCLUSION

It is difficult to write a conclusion for this thesis. It is wise for one to realize that at the completion of the work outlined, it is, in fact, not the conclusion. This paper has only described a small block of time involved in the studio setup.

It is very easy to become so enthusiastic about the work on the shop that one forgets that one is only producing another tool. This is not meant to be a warning. So far, I have appreciated the total experience.

SIMPLIFIED

Sears

Electrical Wiring

Handbook for Planning • Installing • Expanding • Modernizing

50¢ PRICE

You and Sears can do great things

An easy-to-follow guidebook for the do-it-yourselfer

Add new CONVENIENCE.. SAFETY..VALUE to your home with up-to-date wiring geared to today's needs

Do you know that . .

90% of our nation's homes are inadequately wired

Chances are that any home over 20 years old should be rewired

Many homes less than 20 years old need rewiring . . or improved wiring

As the use of appliances increases.. so does the load on your wiring

Keep future loads in mind as you plan your wiring now

As new electrical products planned for your convenience and comfort appear, will you be able to enjoy them? Yes, with careful planning today—no, if you add them to an inadequate set-up such as is found in 90% of our homes.

If your present electric servants are inefficient unsatisfactory—your wiring already works too hard. Year after year, you need more electricity for good living. Check your wiring now—be ready for the good life!

Sears materials meet all requirements: National and local codes, REA specifications . . and are UL listed

 15705 (F5428) Rev. 3-73

FIVE SURE SIGNS your wiring is out-of-date

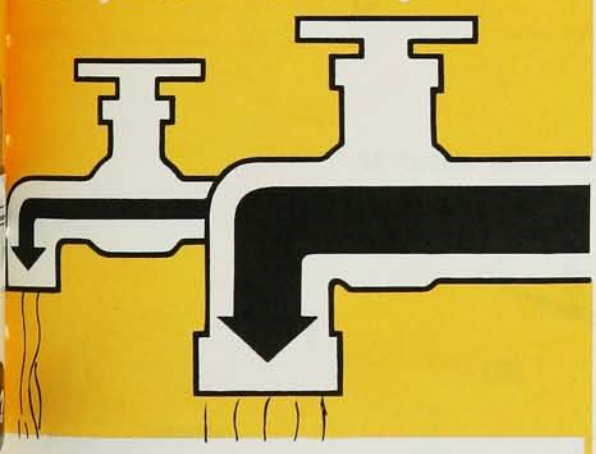
1. Fuses blow . . circuits trip frequently
2. Lights dim, blink, flicker annoyingly
3. Television picture wobbles and shrinks
4. Appliances take longer to heat
5. Air conditioner fails to do its job

Use of electricity has tripled in the average home in the last 30 years

. . and it mounts, year by year. Your wiring that so adequately took care of your needs in the 40's . . does it stand your new equipment without blowing fuses, tripping circuit breakers?

If these things happen regularly, your home is inadequately wired right now. Don't ignore these danger signals. Plan now to live better electrically by bringing your wiring up to date.

Your electrical system is like your water system

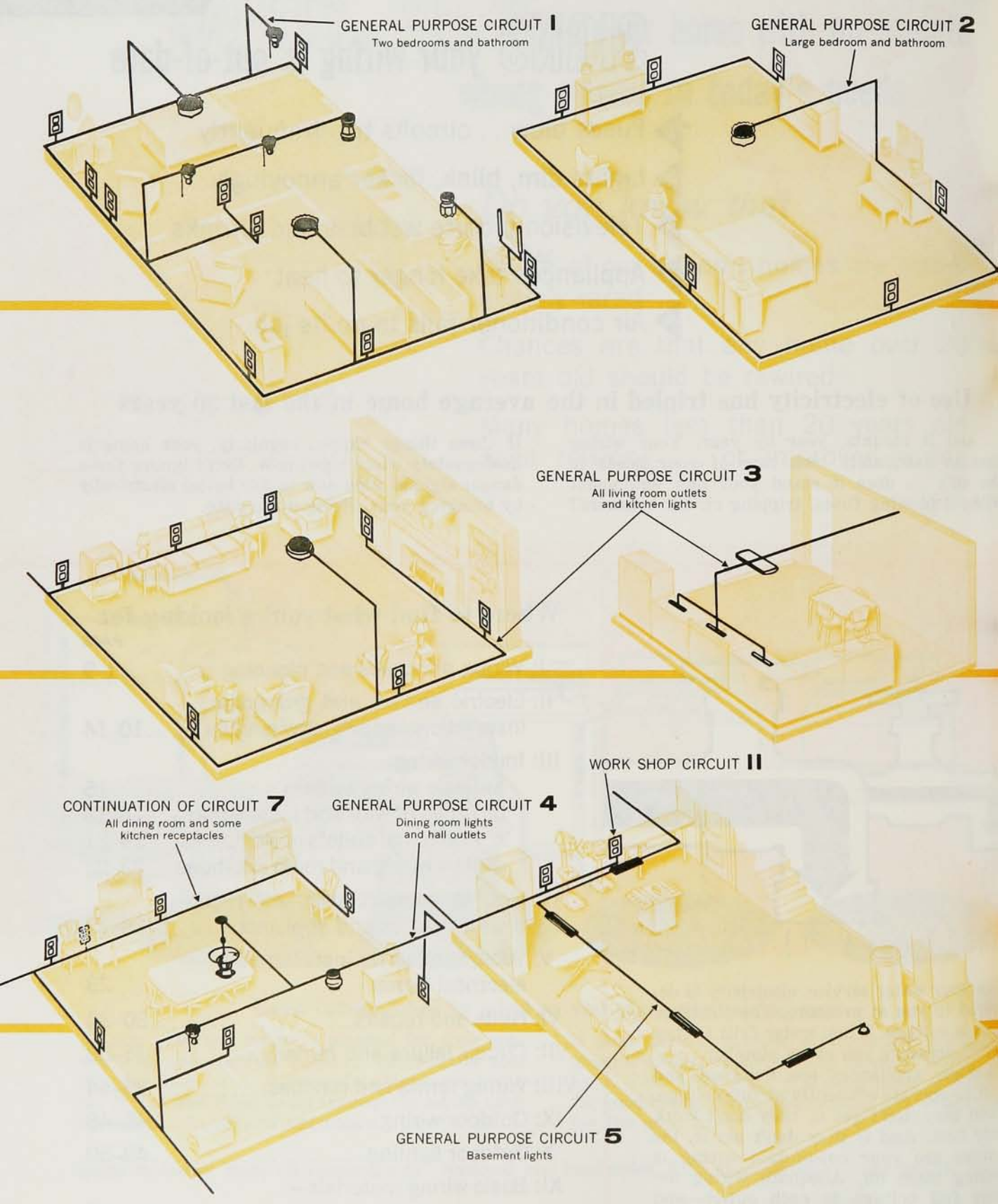


Like your water service, electricity is delivered to you at pressure. The electrical term is voltage. When water fails to flow at full pressure you call a plumber.

Lamps, appliances are designed and built to operate efficiently at full voltage. When they don't get it, they don't work their best. And *if* they don't get it, the chances are your out-of-date wiring is choking them off. Adequate wiring delivers full voltage to each outlet—and provides enough outlets and switches for your complete comfort and convenience.

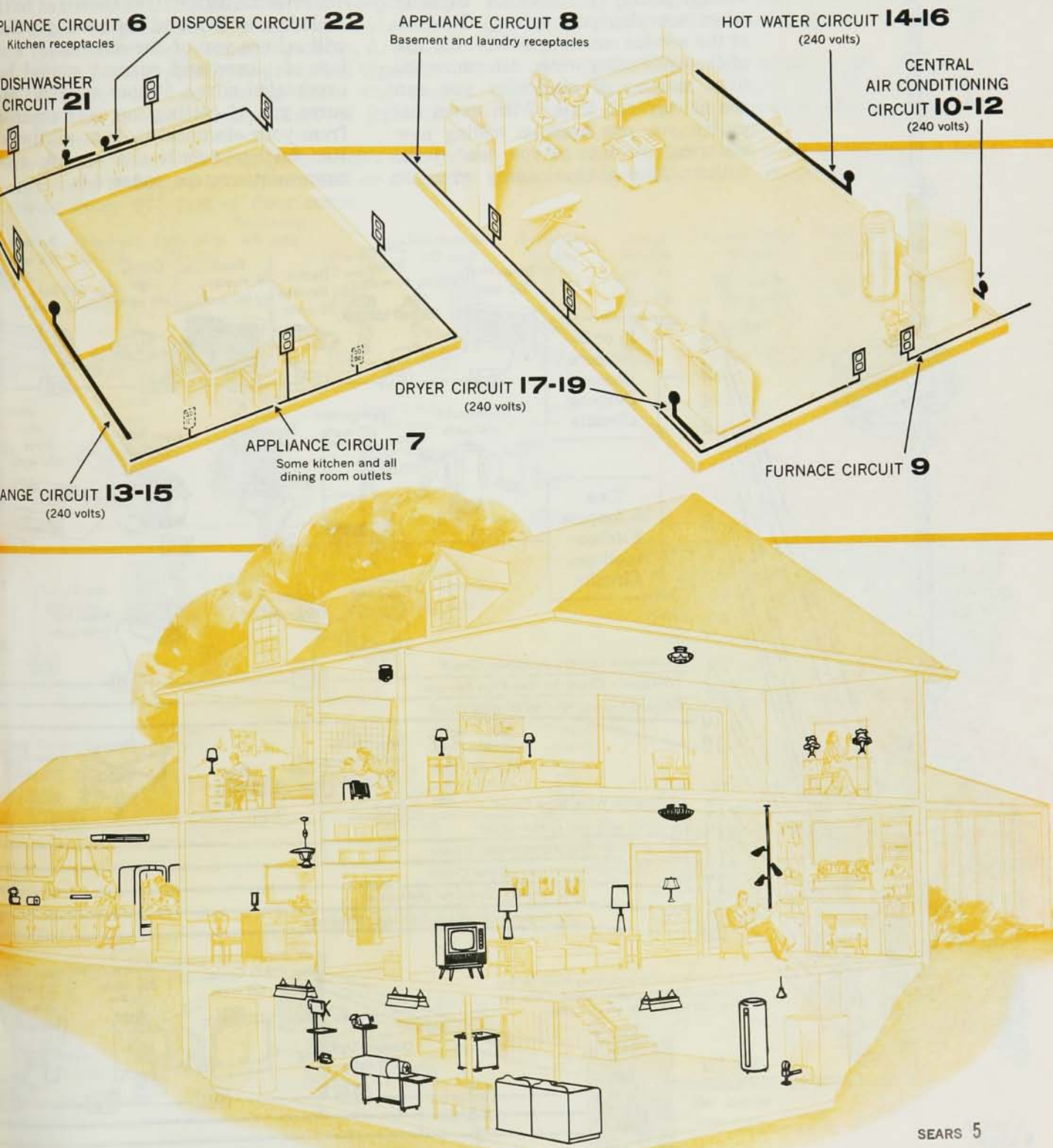
Where to find what you're looking for

Up-to-date Wiring provides enough



circuits for present and future needs

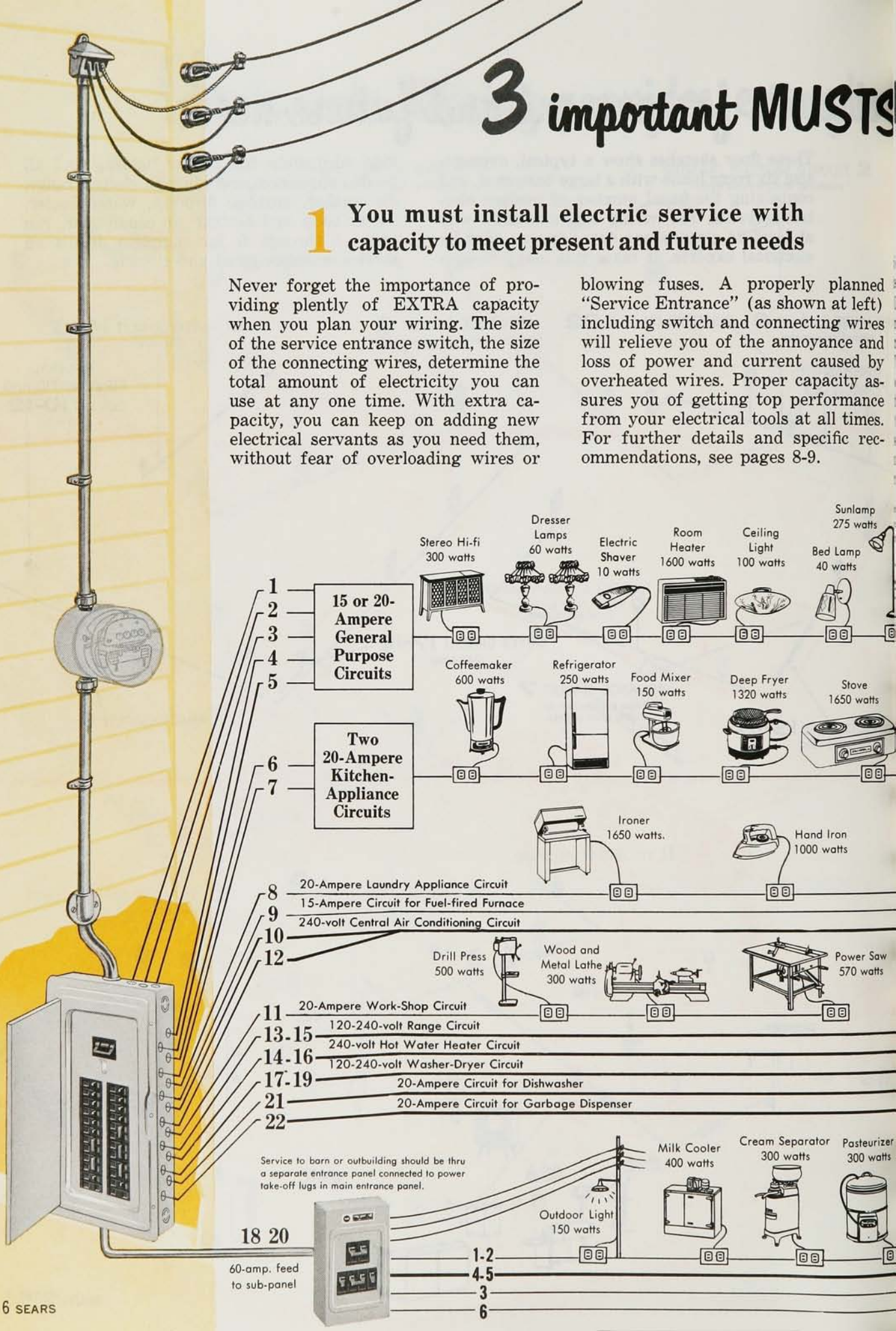
These floor sketches show a typical, average-size six room home with a large basement, and containing the usual number of modern electric servants. The wiring diagrams show why at least 24 circuits are now recommended by electrical experts. It takes this many to provide adequately for proper lighting and all needed appliances, including an electric range, dishwasher, garbage disposer, water heater, power tools and central air conditioner. See pages 6 through 9 for complete details on service entrance panel and circuits.



3 important MUSTS

1 You must install electric service with capacity to meet present and future needs

Never forget the importance of providing plenty of EXTRA capacity when you plan your wiring. The size of the service entrance switch, the size of the connecting wires, determine the total amount of electricity you can use at any one time. With extra capacity, you can keep on adding new electrical servants as you need them, without fear of overloading wires or blowing fuses. A properly planned "Service Entrance" (as shown at left) including switch and connecting wires will relieve you of the annoyance and loss of power and current caused by overheated wires. Proper capacity assures you of getting top performance from your electrical tools at all times. For further details and specific recommendations, see pages 8-9.



in planning up-to-date wiring

2 You must plan enough circuits to deliver full power always

Divide lights and outlets into various branch circuits as shown.

CODE REQUIREMENTS: all receptacles must be grounded type for new work or replacement on grounded systems. At least TWO 20-amp appliance grounded type circuits for kitchen, dining room and one for the laundry, independent of lighting fixtures.

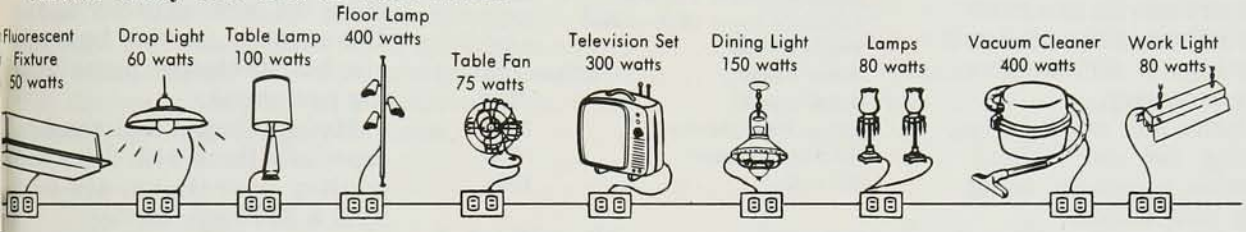
A separate 20-amp general purpose circuit is recommended for every 500 square feet or a 15-amp circuit every 375 feet of floor space.

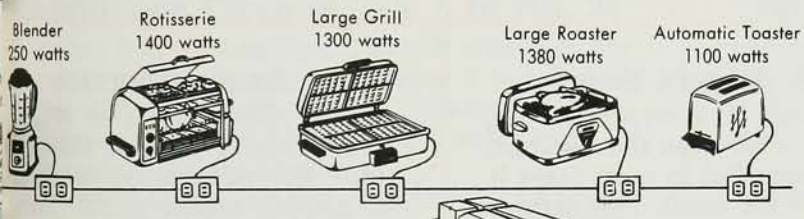
3 You must provide enough outlets on each circuit for convenience

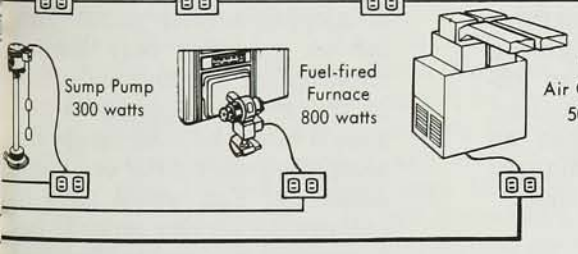
A convenience outlet located every 12 feet of running wall space is required to provide complete flexibility in furniture placement, prevents unsightly long extension cords, assures better lighting.

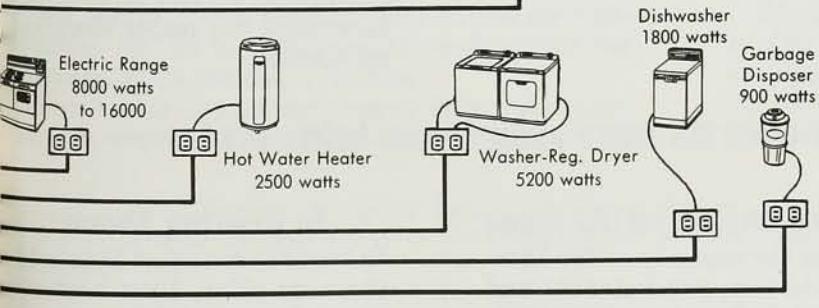
IN KITCHENS, an outlet every 4 feet of counter space provides quick plug-in of appliances without moving them around, lets you make the most of your work space.

Be sure to plan a few outdoor outlets for holiday lighting, appliances or summer fun.









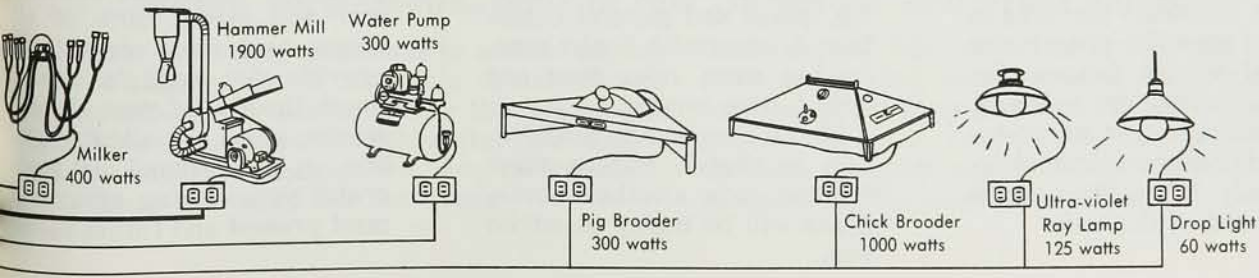


Figure total wattage for each circuit

NOTICE: Good planning insures that all outlets on a floor are not on one circuit. This prevents one blown fuse from throwing a whole floor into darkness. Note 4 circuits on 2nd floor. Note also that dining room, kitchen and laundry are on separate circuits. Put most circuits where load is heaviest.

CAUTION!

Maximum carrying capacity of a 20-ampere general-purpose or appliance circuit with. Number-12 wire is 2400 watts. Check wattages shown here. No combination of appliances exceeding that wattage should be used on any one circuit at any one time.

Select the right Service and Circuits

Facts to help you decide which size Electric Service you should install

150 and 200 Ampere Service

Number 1/0 or number 3/0 (type RHW insulation), 3-wire Electric Service with 150 or 200-ampere service panel respectively, is preferred for modern, up-to-date wiring where full "housepower" is desired. In homes equipped with an electric range, water heater, high speed dryer or central air conditioning together with lighting and the usual small appliances, you will need a 150-ampere service as a minimum. With the addition of electric heating, a 200-ampere service is necessary.

Most farms and ranches are also finding 150 and 200-ampere service necessary using yard pole distribution.

Appliance	Watts
Fuel-fired Heating Mechanism	800
Dishwasher-Waste Disposer	1500
Central Air-conditioner	5000
Automatic Washer	700
Automatic Dryer (regular)	4500
Automatic Dryer (high-speed)	8700
Water Heater	2500
Water Pump	300 to 700
Home Freezer	350
Built-in Room Heater	1600
Garbage Disposer	900
Dishwasher	1800

A 150-ampere service provides sufficient electric capacity for lighting and portable appliances including ironer, roaster, rotisserie and refrigerator, 12000 watt range, and 8700-watt clothes dryer and also for 5000 watts (3 to 5 tons) of central or room air conditioning plus any of the appliances listed in table at left, up to 5500 watts.

A 200-ampere service provides the same capacity as the 150-ampere service but will also handle electric house heating equipment.

Modern farms and ranches, especially those with dairy and poultry operations, are best with a 200-amp. service.

100 Ampere Service

Number 2 or number 3 (type RHW insulation), 3-wire electric service with 100-ampere service panel is minimum according to the National Electric Code for homes up to 3000 square feet in floor area. In most areas, the minimum Electric Service for new homes is 100-ampere for lights, roaster, ironer, refrigerator and 8000-W. range plus appliances in table above up to 10000-W. total.

60 Ampere Service

Number 6, 3-wire Electric Service has been the standard for years but in most cases it is now too small. This service provides capacity for lighting and portable appliances including range, dryer-regular, or hot water heater **but no additional major appliances can be added at any time.**

30 Ampere Service

This service consists of Number 8, 2-wire Electric Service (for 120-volts only) with a 30-ampere service panel. This service provides only limited capacity for lighting and a few of the smaller appliances and should never be used except for temporary service or one room buildings. You would have to enlarge the service capacity before using any major electrical appliances.

When buying a home be sure to check the entire wiring system before you buy

When buying a new home

Be certain you check the size of the Electric Service wires and Electric Service Panel before you buy. If you are planning to build, be sure the proper size electrical service, branch circuits and outlets are specified. The additional cost of up-to-date wiring over minimum wiring is only 1% to 2% of the original cost of the home.

When buying an old home

Check the capacity of the Electric Service, panel circuits and outlets just as you check roofing, paint and general condition. A home with 3-wire service has more value than one with 2-wire service.

If you require any modification in electric wiring when moving into another home, Sears will be happy to advise you.

In existing homes

Remember that few homes 15 years or older, have been rewired for up-to-date convenience and safety. 90% of all homes need some rewiring to provide for today's needs. Check the size of your electric service, panel, circuits and outlets . . . then expand and modernize your wiring system to meet present and future needs.

to custom-build full "housepower"

Easy-to-set-up Efficient Circuits for all lights and appliances

General Purpose Circuits, No. 1 to 5

For Diagramed Illustrations of all Circuits, 1 through 24, see Pages 6 and 7

Circuits No. 1 to No. 5 supply all the lighting outlets and all convenience outlets except in kitchen, dining area and laundry. These circuits should be set-up on the basis of one 20-ampere, 120-volt circuit for not more than each 500 square feet of floor space, or one 15-ampere 120-volt circuit for not more than 375 square feet of floor space.

Outlets on these circuits should be divided equally among the circuits. Convenience outlets should be placed every 12 feet along wall. Use standard duplex outlet for small appliances or you may wish to install the extra convenient combination devices. (See page 51.) National Elec. Code demands grounded-type receptacle.

Appliance Circuits, No. 6 and 7

There should be at least two 20-ampere circuits in the kitchen and dining area plus one 20 ampere circuit for the laundry (See Nos. 6, 7 and 8 on pages 6 and 7).

Do not install lighting on the kitchen, dining area or laundry circuits. Provide plenty of convenience outlets . . . at least one for every 4 feet of kitchen counter work area. For special Kitchen Appliance Center outlet see page 38 of this Handbook. Install grounded-type duplex receptacle.

We suggest diagramming all circuits you plan to install, this will enable you to establish a materials list. Consult the trained people at Sears for helpful suggestions and estimates on the cost of materials and equipment.

Appliance Circuits, No. 8 to No. 24

Number 8 is a 20-ampere, 120-volt circuit to the laundry appliance outlets. **Number 9** is a 15-ampere, 120-volt circuit to the fuel-fired heating equipment. **Number 10-12** is a 240-volt circuit to the central air conditioner.

Number 11 is a 120-volt circuit to the garage or workshop. **Number 13-15** is a 50-ampere, 120/240-volt circuit to the electric range. **Number 14-16** is a 20-ampere, 120/240-volt circuit to the water heater. **Number 17-19** is a 30-ampere 120-240-volt circuit for automatic washer and electric dryer. Washer uses 120 volts, dryer uses 120/240.

No. 18-20 is a 60-amp. 240-volt circuit to a subpanel. **No. 21** is a 20-amp. 120-volt circuit for dishwasher. **No. 22** is a 20-amp. 120-volt circuit for disposer. 23-24 are spare circuits.

For 3-wire circuits and heavy duty outlets for ranges, dryers and water heaters, see page 26.

Sub-panel Circuits, No. 1 to No. 6

For the most efficient electric service on farms, many farmers now install a 100-ampere subpanel in the barn connected from the main service panel on the yard pole or any other location (in our example this would be circuits 18-20).

Circuit 1-2 (pages 6 and 7) could go from subpanel to milkhouse for lights and equipment. It uses circuit breakers in the panel and 3-wires and is a 120/240-volt, 20 amp. circuit.

Circuit 3 is an individual 120-volt circuit with separate switch for the water system.

Circuit 4-5 connects to the feed grinder or large motor and is 120/240-volts.

Circuit 6 is a 120-volt, 20-ampere circuit that is ideal for supplying the poultry house with power. Egg production, especially during the winter months, can be substantially increased by means of artificial light.

Note. .Number 12 wire is recommended throughout the house. However, Number 14 wire can be used for 15-ampere circuits, and Number 12 for 20-ampere circuits.

Follow recommendations in this Handbook and avoid dangers

Overloaded wires may cause fires or serious damage to the wiring system. A fuse or a circuit breaker protects wires from overloads. For this reason you should never use a fuse or circuit breaker rated higher than the ampere capacity of the wire. Never substitute a penny or wad of foil for a fuse.

Don't handle "hot" electrical equipment, including fuse boxes, when standing on a damp surface or basement floor. Wear gloves or rubbers and stand on a dry wood board. Touch one hand only to the fuse and keep the other hand free, not touching the wall or anything. See pages 35-36 of booklet.

section 2

Electric Service and Grounding Installations

How to get off to the right start

Prepare Work Plans

The first step is to prepare plans in accurate scale for every building. Such plans help you determine exactly how much material will be needed and also serve as practical working guides when making the installation.

Check with Power Company

The second step is to consult with your local Power Company. They will advise you as to what type of Electric Service to use . . . whether a yardpole is required . . . how much of the installation the Power Company will handle, etc. In most localities, the Local Utility Company will make the installation to the side of the house or yardpole.

Is a Permit Necessary?

Find out whether you need a wiring permit before starting the installation. Securing the permit (if needed) should not be difficult, provided you have mastered the information in this book and acquainted yourself with the regulations of the National Electric Code so that your installation will pass inspection for safety.

The National Electric Code is a book of regulations specifying correct installation methods and types of materials acceptable for various jobs. Your local Power Company can furnish a copy.

Check Local Regulations

In some communities local regulations sometimes supersede the National Code, so know what these local regulations are. Also be sure that materials you intend to use are approved by your Power Company.

All Sears Materials are UL Listed

When buying wiring materials look for the Underwriters' tag or stamp to make sure that they meet minimum standards for safety and quality. Don't take chances with inferior materials which have not been listed by Underwriters.

on your Wiring Project

What every one installing wiring should know about Electric Services and Service Panels

The heart of up-to-date wiring

Your electric service installation is the heart of your system. It includes all wiring from power lines to service panel, as shown at right. With a proper installation current is delivered to the panel at full voltage.

Then, with up-to-date wiring in your home, current will flow to all outlets without loss and lights and appliances will operate efficiently. Remember, if service wires are too light and panel too small, you're in for trouble.

How to select and locate your Electric Service

To select the right size electric service wires and panel see pages 8 and 9 for detailed information based on the number and type of appliances you intend to use. See page 40 for yard pole service.

Your local Power Company will decide where the electric service will enter your building. Service panel should be located near rooms where largest amount of current will be needed...usually the kitchen.

Check with Utility Company

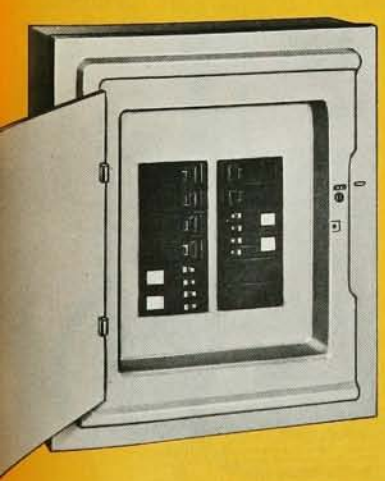
The Power Company usually supplies the meter and sometimes furnishes and installs all wiring leading to the meter. Wiring beyond the meter is your responsibility.

Wires should run as directly as possible from electric service head down wall to meter and panel, as shown at right in typical installation for city and town homes.

Use Service Cable or Conduit for installation

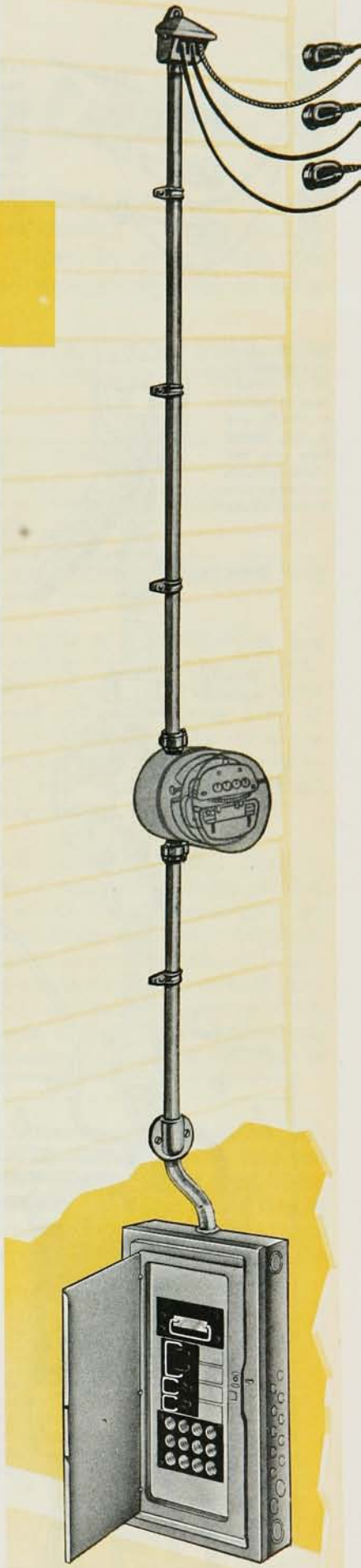
Electric service installation may be made with either (1) service cable or (2) rigid or thin-wall conduit. Which you use depends on state or local requirements, so check before you start.

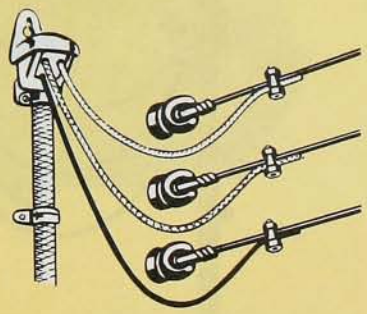
Service cable is the material most often used . . . armored or unarmored depending on locality. Its advantages are low material and installation cost. Conduit is steel pipe through which wires run.



Fuseless and Fused Panels

The fuseless, circuit-breaker type (left) eliminates fuses. If a circuit is overloaded or shorted, the breaker automatically breaks the flow of current. Just flip switch to restore service after cause of short has been corrected. A fuse-type panel (right) may also be installed. It is less expensive but the fuseless type is much more convenient and economical, because the circuit breakers are simply reset whenever overloads occur—they need not be replaced. See pages 54-55 for complete information.





To Connect Wires from Entrance Head to Overhead Wires the National Electric Code requires that the service Entrance Head should be installed above the top insulator of incoming power wires. Drip loops shall be formed on individual Conductors. This will prevent water from entering the electric service system.

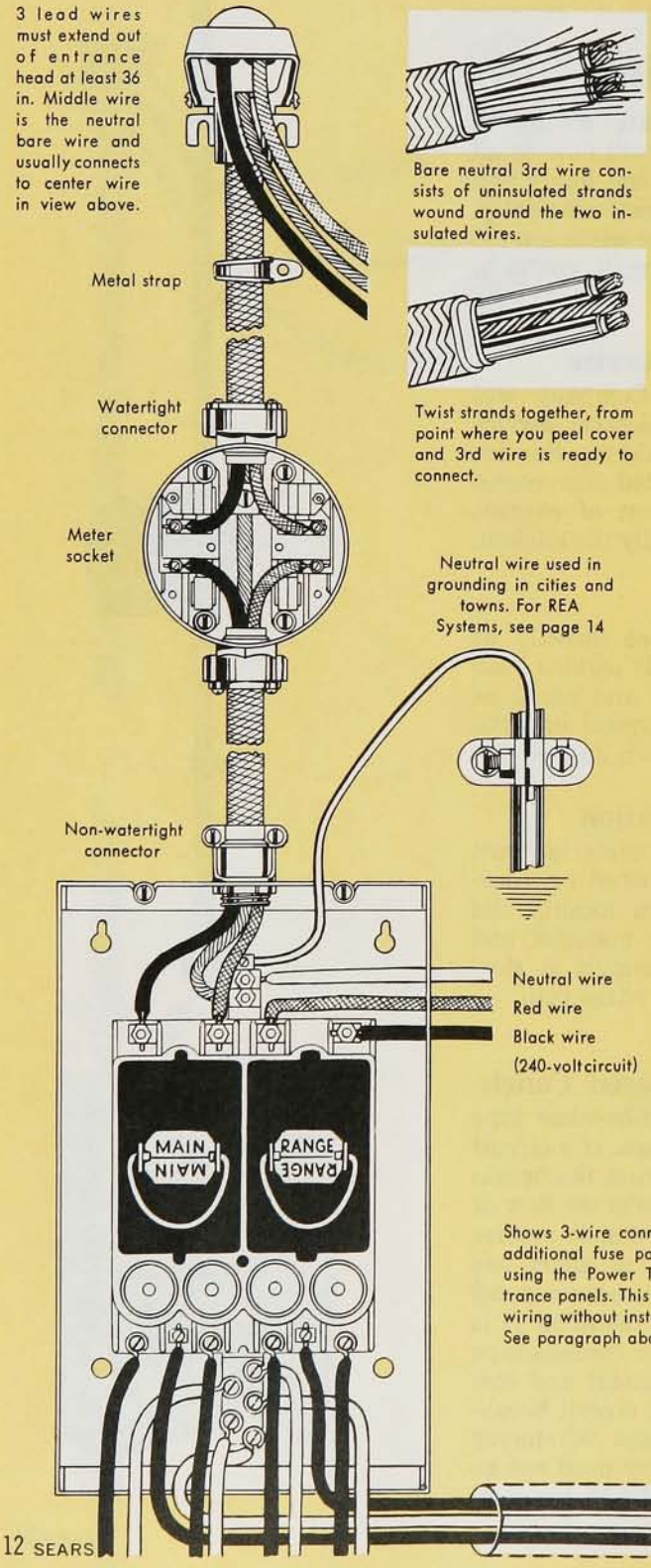
To install Electric Service using Entrance Cable

Attach Entrance Head to building at least 10 feet above ground. Strip outer cover from Entrance Cable so that wires can be extended through Entrance Head for at least 36 inches. This allows plenty of length for connecting to power lines. The power lines attach to the building with insulators, located high enough to clear trucks or wagons.

Anchor cable every 4 feet with straps. To hold cable in meter socket use 2 connectors . . . one where cable enters meter, one where cable leaves meter. Run cable down wall and through hole drilled through building. Connect to Service Panel which should be located within one foot of where cable comes in. Use sill plate to protect cable where it enters building.

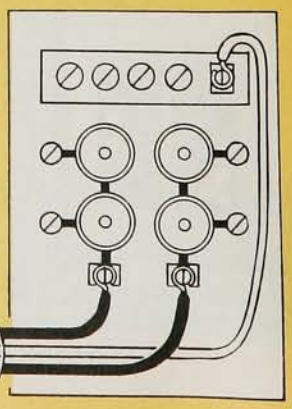
Connections to Service Panel. Black wire of cable connects to left terminal of main disconnect and red wire to right terminal. Third or bare neutral wire to the neutral strip which is grounded by connecting it with a bare wire to water pipe system.

Branch Circuits: Below each fuse is a terminal to which a black wire is connected. White wires are connected to neutral strip. A black and a white wire give a 120-volt circuit. Black wire is fused with a 15 or 20 amp. fuse. Panel has 4 branch circuits.



To add Circuits to Power Take-off

Most Service Panels have 2 Power-take off Lugs set between the two left and two right plug fuses. To add additional circuits, a new add-on fuse panel, circuit-breaker panel or safety switch can be installed as illustrated below. The two black wires go to the Power-Take-off Lugs and the white wire connects to neutral strip. This will give 120-volts between the black and white wires or a 240-volt circuit between the two black wires, at new panel. Such a panel is necessary for circuit protection because the Power-Take-Off is fused at 60-amperes in the main disconnect, 3 wire No. 10 is minimum wire size permitted.

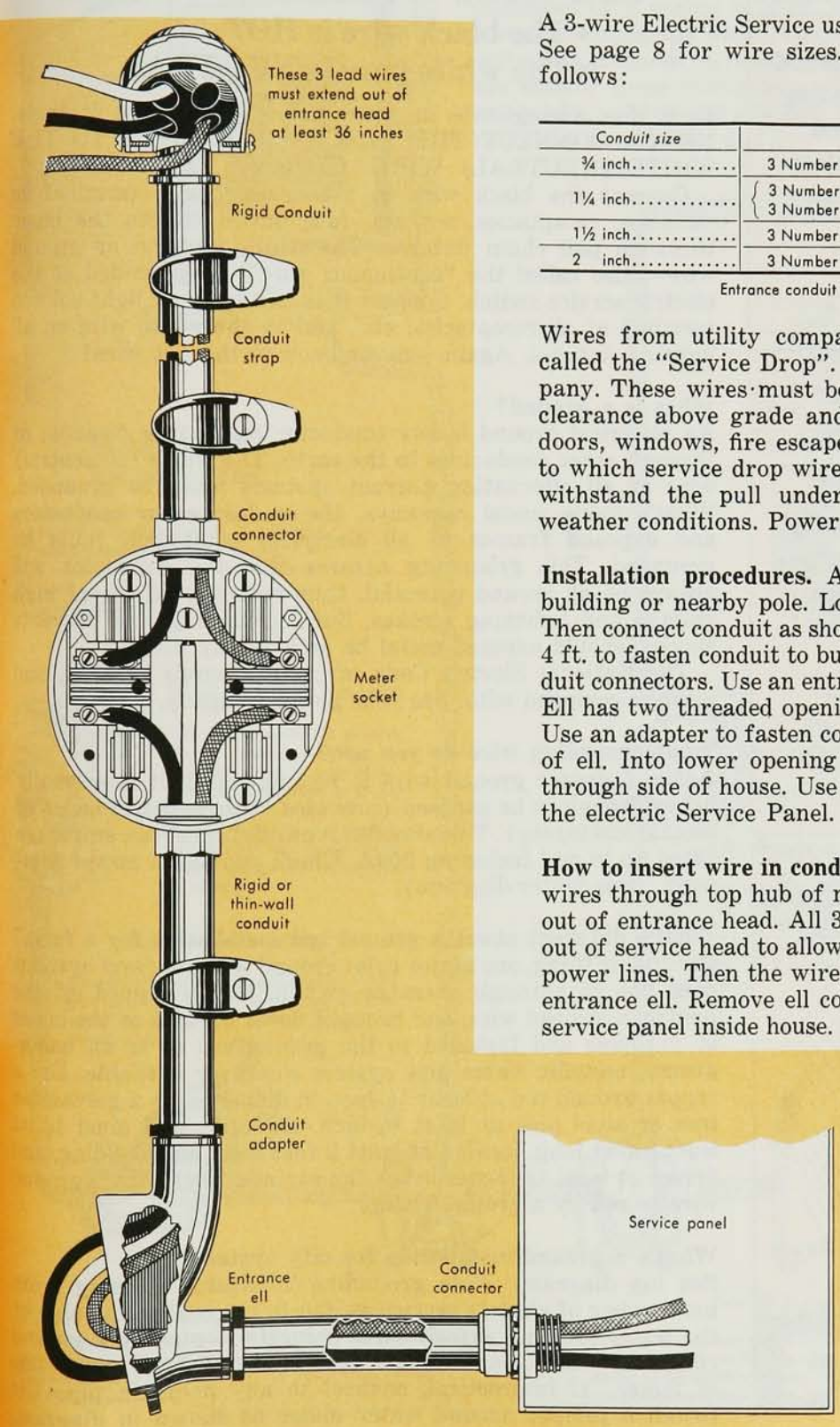


Shows 3-wire connections for installation of either an additional fuse panel or an additional safety switch, using the Power Take-off Lugs available in most entrance panels. This permits partial extensions of existing wiring without installation of a bigger entrance switch. See paragraph above for full details.

To install Electric Service using Conduit

The installation below shows the use of conduit. Conduit or armored cable if used for all circuits within the home would give you a grounded system. Note the use of rigid conduit above the meter socket.

Conduit is not difficult to install. Only tools needed are conduit bender, hacksaw, screwdriver, hammer, pliers. In some areas conduit must be used exclusively. Check code.



A 3-wire Electric Service uses 1 black, 1 red and 1 white wire. See page 8 for wire sizes. Then determine conduit size as follows:

Conduit size	*Conduit capacity*
¾ inch.....	3 Number 8 wires
1¼ inch.....	3 Number 2 wires, 3 Number 3 wires, 3 Number 4 wires, 3 Number 6 wires
1½ inch.....	3 Number 1 wires
2 inch.....	3 Number 1/0 wires, 3 Number 2/0 wires, 3 Number 3/0 wires

Entrance conduit runs cannot be over 50 feet

Wires from utility company's pole to your building are called the "Service Drop". . . usually furnished by the company. These wires must be high enough to provide proper clearance above grade and must not come within 3 ft. of doors, windows, fire escapes or any opening. The structure to which service drop wires are fastened must be sturdy to withstand the pull under ice and wind storms and all weather conditions. Power company can advise.

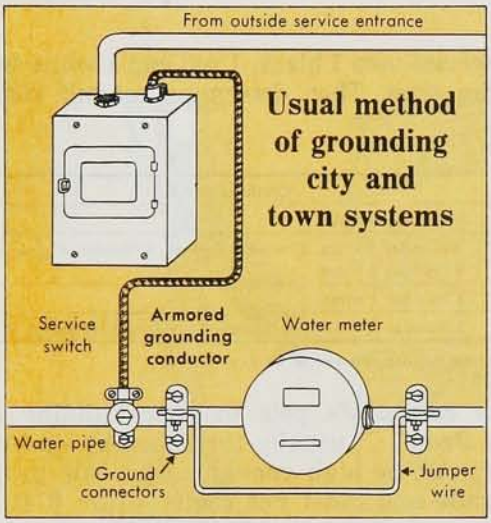
Installation procedures. Attach Service Entrance Head to building or nearby pole. Locate at least 10 ft. above ground. Then connect conduit as shown at left. Use a metal strap every 4 ft. to fasten conduit to building. Connect to meter with conduit connectors. Use an entrance ell to turn conduit into house. Ell has two threaded openings corresponding to conduit size. Use an adapter to fasten conduit into threaded opening at top of ell. Into lower opening fasten a piece of conduit to run through side of house. Use connector to attach the conduit to the electric Service Panel.

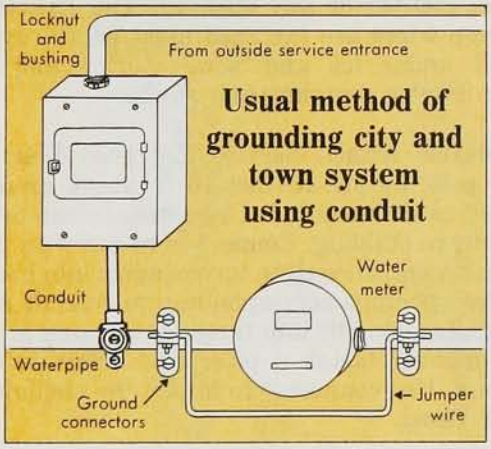
How to insert wire in conduit. After conduit is installed push wires through top hub of meter up through conduit into and out of entrance head. All 3 wires must extend at least 36 in. out of service head to allow plenty of length for connecting to power lines. Then the wires are brought down from meter to entrance ell. Remove ell cover and pull wires through to the service panel inside house.

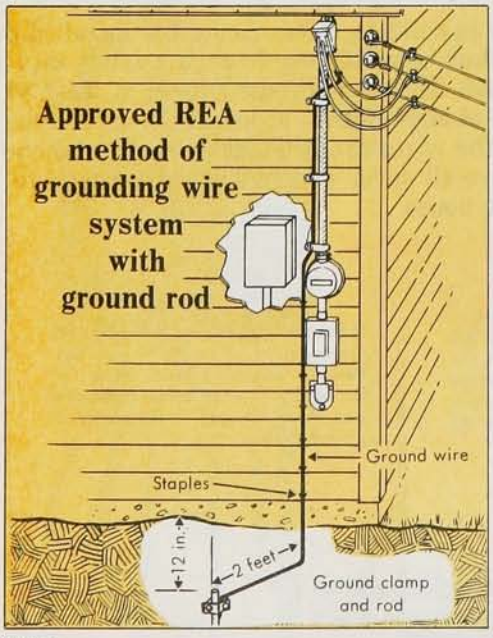
Connections to electric service switch are the same as described and illustrated on preceding page, except that for conduit a *white covered insulated wire* should be used as the neutral or grounded wire.

Grounding the Electric Service

HOW TO GROUND YOUR ELECTRIC SERVICE CORRECTLY







Color coding or polarization of system

- **The black wire is HOT**
- **The white wire is NEUTRAL**

Etch this wiring rule in your memory and keep it there. NEVER CONNECT THE BLACK (HOT) WIRE TO THE WHITE (NEUTRAL) WIRE. (Exception: see 24-25.)

Connect the black wire to the brass-colored terminal on switches, receptacles, sockets, fuse boxes, and to the black wires on pull chain fixtures. The white (neutral or ground wire—also called the "continuous wire") is grounded at the electric service switch. Connect it to the silver or light-colored terminal of all receptacles, etc., and to the white wire on all lighting fixtures. Again—never hook to the hot wire!

What is a ground?
An electrical ground is any conductor connecting directly, or through other conductors to the earth. The white (or neutral) wire of all alternating current systems must be grounded. What's more, metal raceways, the enclosure for conductors and exposed frames of all electrical equipment must be grounded. This grounding assures that the conductor will always be at ground potential, thus reducing effects of high voltage and lightning strokes. Such grounding also prevents shocks, should exposed metal be accidentally livened.

The National Electric Code covering grounds is strict, and *must* be complied with. See your power company.

What grounding wire do you use?
A No. 4 copper ground wire is recommended, it is normally heavy enough to be exposed (provided there is little chance of mechanical injury). This size also is usable for service entrances rated up to and including 200A. Check your local power company. (See center diagram).

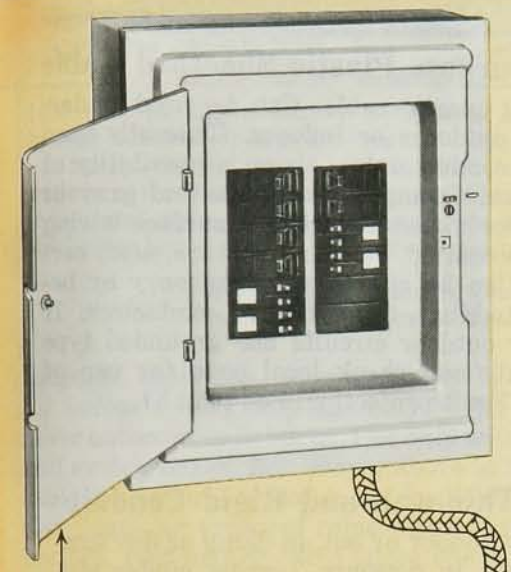
What's different about a ground rod installation for a farm?
One major thing, one major rule: ground wire for farm systems does not go through entrance switch, but is tapped off the neutral overhead wire, and brought down the side of the house or yardpole and fastened to the ground rod or to an **underground metallic water pipe system** wherever available. Use a copper ground rod at least ½-inch in diameter, or a galvanized iron or steel pipe at least ¾-inch diameter. Rod must be at least 8 feet long, located at least 2 feet from any building, and driven at least 12 inches below the surface. Then attach ground wire to rod by a ground clamp.

What's a ground installation for city systems?
See top diagram. Note grounding conductor running from neutral bar of electric service switch to the cold water pipe of the water system. Attach wires securely to pipe by a ground connector. Best: make water pipe connection on street side of meter. If impractical, connect to any point on pipe but install a jumper around water meter as shown in diagram.

Basic Wiring System Simplified

Operation of a single, simplified circuit

Here, in simple diagram form, you are shown the elementary principles of a wiring system. Note how the black and white wires are connected within the boxes for all basic devices. You will see that almost anyone capable of using his hands and head can master these principles and install a wiring system that will be dependable and efficient. This book, if studied carefully, will show you how to do it.

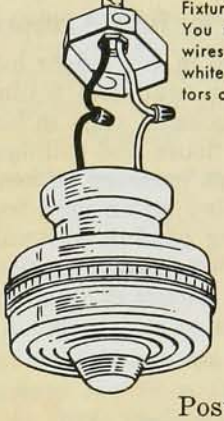


Electric Service Entrance Panel

Main distribution panel which directs current to branch circuits. It not only protects each circuit against danger of overload, but lets you disconnect your wiring system instantly in emergencies or when altering wires or making repairs.

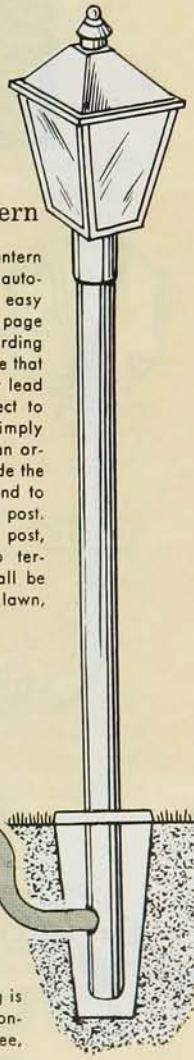
Light Fixture

Fixtures come already wired. You merely connect the outlet wires, black to black, white to white, using solderless connectors as shown.



Post-top Lantern

Installing an outdoor lantern (with or without an automatic time switch) is easy and inexpensive. See page 49 for details regarding new underground cable that requires no conduit or lead sheathing unless subject to mechanical injury. Simply run your wires from an ordinary switch box inside the house, and underground to opening at bottom of post. Then, up the hollow post, connect to the lamp terminals—and there shall be light to beautify your lawn, garden or driveway.

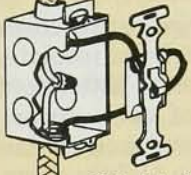


Wall Bracket Fixture

For kitchen, bathroom or over mantel. Usually controlled by separate switch at base of fixture. Easily installed in an ordinary switch box. No solder or tape needed—simply use solderless connectors as shown. (Note black hooked to black, white to white.)

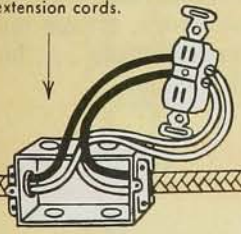
Light Switch

Single pole switch, used to control light from 1 point. For 2-point control use two 3-way switches. See page 24 for wiring instructions.



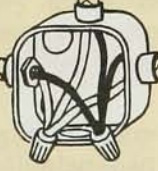
Receptacle Outlet

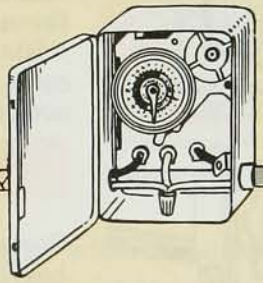
A handy tap. Just insert plug to obtain current. Plan on plenty of these so you can plug in lamps and appliances without using long extension cords.



Junction Box

A device used to run wiring of a branch circuit in two or more directions. Simply splice white wire to white, black to black, using solderless connectors. The junction box is occasionally used as a ceiling box for lights, or as an outlet box for receptacles.





Automatic Time Switch

Turn lights or power on and off at any set time. Note that the wiring is exactly the same as for any other switch. The two black wires are connected to the switch terminals. The white "neutral" wires, you will see, are connected to each other. White to white . . always!

Selecting the right wire..

Indoor-type Plastic Sheathed Cable

Tough, flexible outer jacket is ivory color and flat in shape. Use for all indoor wire runs. Easy to pull and strip. Heavy inner thermo-plastic insulation. Solid copper conductors. New work or additions require use of grounded type receptacles, therefore, use "with ground" type cable. SPECIAL NOTE: When using aluminum cable or replacing devices on aluminum wired circuits use CO/ALR rated devices only.

Dual-purpose Plastic Sheathed Cable

Our best plastic cable. Can be used underground, outdoors or indoors. Generally used without conduit unless there is possibility of mechanical damage. Flat shape and gray or ivory color makes it ideal for surface wiring where permitted. Resists moisture, acid, corrosion. Can be run through masonry or between studding. Solid copper conductors. If used for outdoor circuits use grounded type cable only and check local code for use of Ground Fault protection. See page 51.

Flexible Armored Cable

For use in dry indoor locations. Can be used on wall and ceiling surfaces, or for concealed runs in hollow spaces of walls, floors and ceilings.

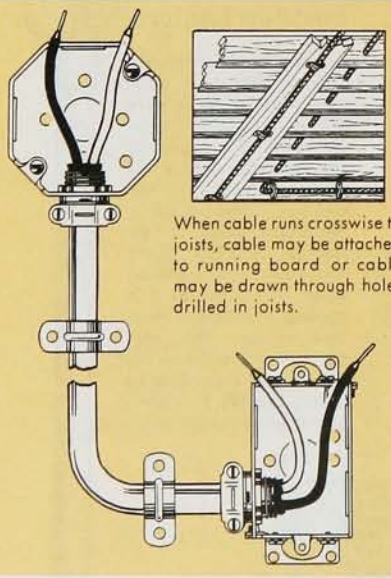
Wires enclosed in heavy steel cover. Flexible . . often used for extensions of existing conduit systems. Usable with *steel* switch and junction boxes *only.*

Not for use in damp indoor locations, outdoor or underground.

Thin-wall and Rigid Conduit

Use indoor or out, in damp or dry locations, in masonry (except cinder concrete). Generally used in new work only because it is difficult and costly to install in old buildings.

Rigid conduit is made of steel with galvanized finish . . thin wall is much lighter, easily cut or bent.



When cable runs crosswise to joists, cable may be attached to running board or cable may be drawn through holes drilled in joists.

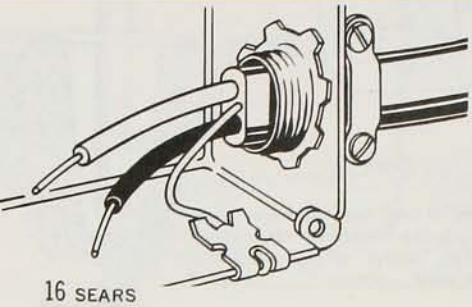
HOW TO INSTALL NON-METALLIC CABLE

Strip cable cover allowing at least 8 in. of insulated wire for connection. Fasten connector to outside of cable cover and insert in knockout hole of box. Screw locknut up tightly from inside.

Rules for exposed work. Strap cable every 3 ft. on supporting surface such as stud, joist, wall or ceiling. When run across joists or through open spaces, cable must be supported by a running board (usually 1x2 in.) or drawn through holes drilled in center of joists or studs. When bending cable be careful not to damage protective covering.

In attics or roof spaces run cable across top of floor beams, or across face of rafters at least 7 ft. from floor and protect cable by guard strips. If attic is not reached by stairway, guard strips will be required within 6 ft. of ladder hole.

Rules for concealed work. Strap cable every 4½ ft. (never use staples) . . . also strap within 12 in. of all outlets and switches. In new buildings straps must be used for all runs whether concealed or exposed. In old work, straps must be used for exposed runs . . . but not for concealed runs.

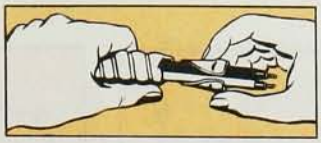


HOW TO INSTALL GROUND WIRE

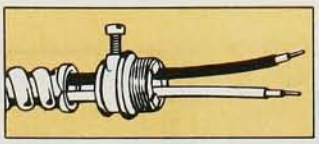
Some local codes require grounded boxes and non-metallic cable with ground wire—similar to plastic sheathed cables described at top of this page. Illustration at left shows a simple installation of ground wire to outlet box. By using non-metallic cable with a ground wire you have a continuous grounded system which assures that the conductor will always be at ground potential, thus reducing the danger of shocks, should some exposed metal be accidentally livened.

How to install Armored Cable

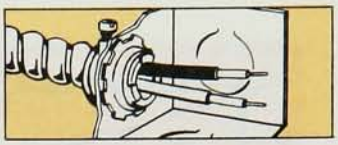
Hold saw at angle. Cut through 1 section of armor then twist to break. Do not cut into wires. Allow 8 in. of insulated wires for connections in box.



Removal of armor exposes water-repellent paper around wires. Insert bushing between paper and wires. Never overlook this very important step.



Remove paper, slip connector with locknut removed over wires and armor. Be sure fiber bushing is touching front of connector, then tighten screw.



Wires, with connector fastened are inserted through knockout of box. Screw locknut to connector and draw up tightly to assure a good ground for safety.

NOTE: Some armored cable has a bond wire. This is bent back against armor and fastened to the screw of the connector to assure a permanently low armor resistance.

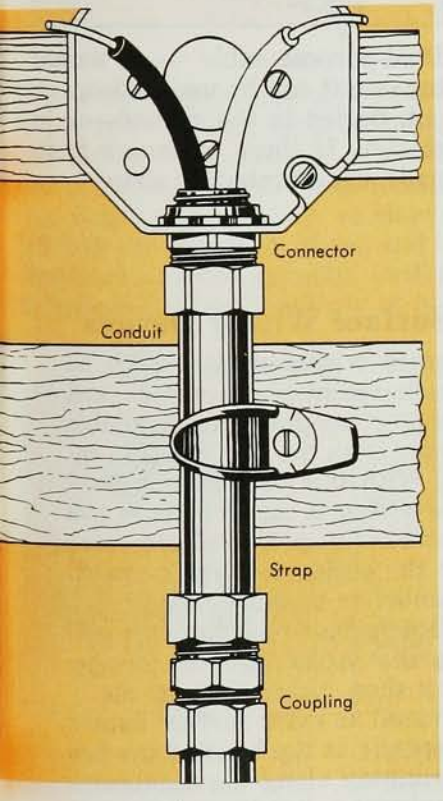
Armored cable has restricted uses. It can be used for *indoor wiring only* and only in dry locations—never outdoors or in barns. Use *only* with steel outlet and switch boxes. Box shown above is fitted with a cable connector, but boxes are available with a special clamp for armored cable which eliminates connectors. Just anchor cable under one of the clamps. All splices must be made inside a junction box.

When cable is cut with saw and twisted apart, a rough, jagged edge will remain. To avoid injury to the insulated wires the Electrical Code *demands* that a fiber bushing be inserted at end of cable.

Armored cable must be supported by a strap or staple every 4½ feet and within 12 inches of each switch box, except for concealed runs in old work where it is impossible to mount straps. Secure straps with screws for a sounder job.

Ampacities for Armored or Sheathed Cable

Size wire	No. 14	No. 12	No. 10	No. 8	No. 6
Maximum capacity	15 Amps	20 Amps	30 Amps	40 Amps	55 Amps



HOW TO INSTALL THIN-WALL CONDUIT

How to select conduit: **½-in. conduit carries four No. 14 wires or three no. 12 . . ¾-in. carries four No. 10 or five No. 12; three No. 8 . . 1¼-in. carries four No. 6; three each No. 2, No. 3 or No. 4 . . 1½-in. carries three No. 1 wires . . 2-in. conduit carries four No. 1/0 or three No. 3/0 wires.**

See page 39 for current capacities of copper wire

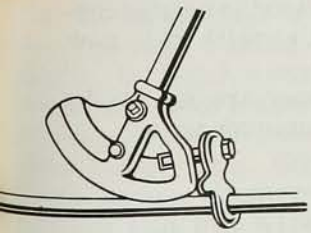
Empty conduit should be mounted in place and connected to boxes before insulated wires are inserted. Conduit must be used with steel boxes only, never Bakelite or porcelain. Conduit comes in 10-ft. lengths which are joined by couplings. Cut shorter lengths with a hacksaw. Ream cut ends inside and taper with file. Use a conduit bender to make all bends.

Support conduit with a pipe strap every 6 feet on exposed runs . . every 10 feet on concealed runs. See page 22.

When connecting conduit to boxes, fit threadless end of connector over conduit and insert connector through box knockout, then tighten locknut.

After conduit and boxes are installed pull wires through conduit into boxes. Allow 8 in. of insulated wire at each box for connections. White wire is "neutral", black or red are "hot".

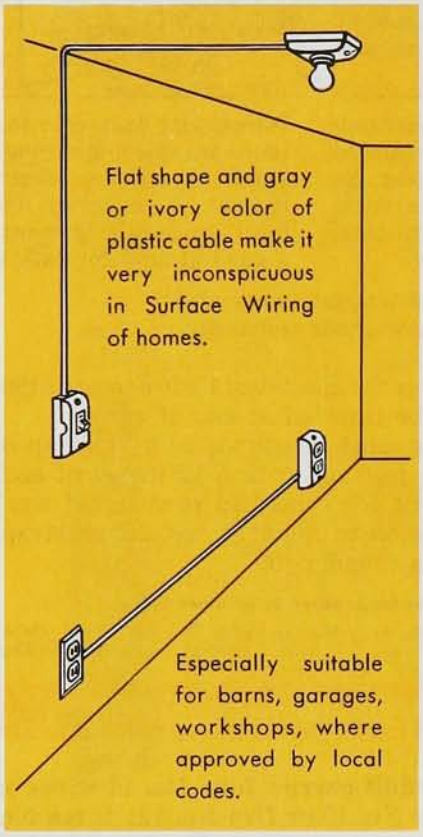
In exposed work, conduit may be mounted on studs or rafters without additional protection. In concealed work conduit must be supported. See page 23.

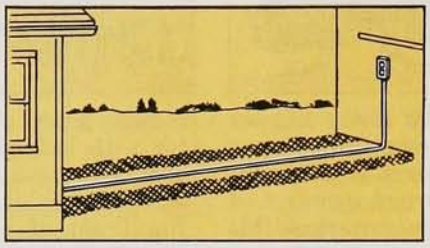


Thin-wall conduit is easy to bend with a conduit bender . .

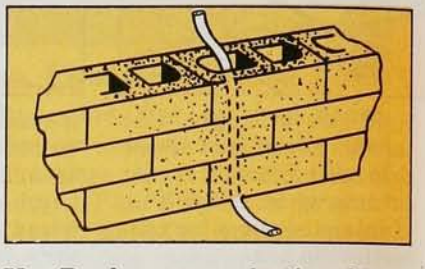
Suppose you wanted a 12-inch 90° bend and were using a combination ½-inch and ¾-inch bender. Measure 7 inches from end of conduit and mark conduit; place bender on conduit with inside of hook at mark; place foot on other side of bender and pull pipe handle until you have a 90° bend. The difference between 12-inch and 7-inch mark on conduit is called "take-up" and is required for radius of bend.

Multi-purpose Plastic Cable saves work



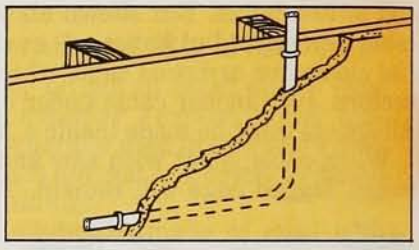


Easily buried underground. Dig trench to depth of 2 feet or more . . . deep enough to avoid injury by shovels, picks, etc. Lay in cable and replace soil.



Use Dual-purpose plastic cable in the air holes of outside masonry block walls. Dampness and condensation have no effect whatever on this cable. It's economical, too.

For new work this cable can be run in partition through studding, the same as ordinary sheathed cable. Ideal in damp, wet locations, flexible and easy to work.



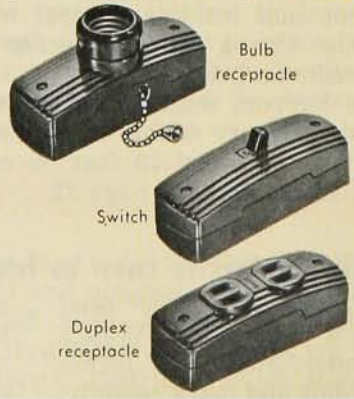
Dual-purpose cable — so named because it can be used indoors or out, buried in the ground—or in plaster. If there is danger from nails, use a protective strip.

Simplifies Surface Wiring

Dual-purpose cable often makes it unnecessary to fish through walls to produce an attractive looking job when rewiring your home, especially in out-of-way places such as pantry, recreation room, work shop, closet or garage.

Illustrations above show how simple it is to add a wall switch to control an existing pull-chain light or to install a new light with switch control . . . also how to run a new surface outlet from an existing flush-mounted outlet.

Where a molded baseboard is present, you can wire down through back of old outlet, drill hole in baseboard, pull through the cable and run it along groove of baseboard to new outlet. Paint cable to match.



Surface Wiring Devices

Surface wiring devices such as a bulb receptacle, a switch and a duplex receptacle are available for use with the dual-purpose cable. With this combination, surface wiring is easier because you don't have to go into plaster, etc., and the outlets and cable are all mounted on the surface.

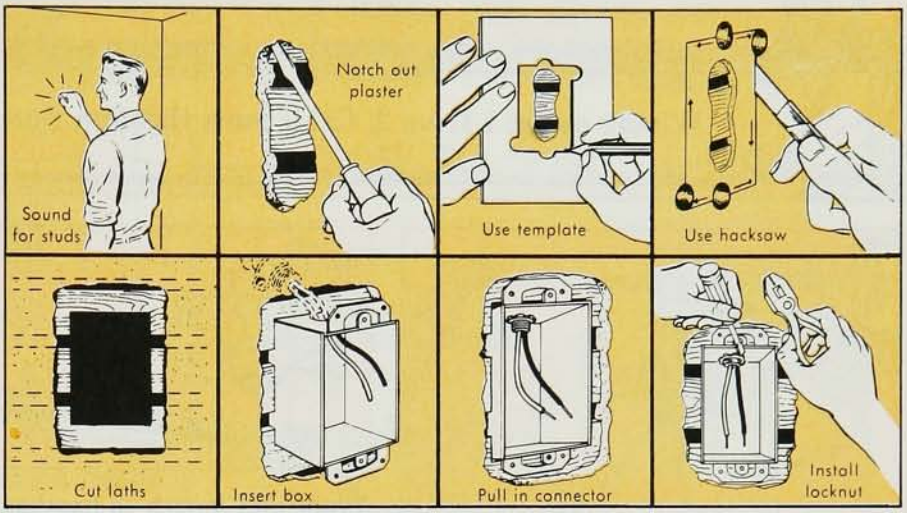
Use the bulb receptacle for putting that extra light in garage, work shop, pantry, closet, etc.

Install an extra surface duplex receptacle at the head of the bed by running along the baseboard. Simply connect to the nearest convenience outlet with this new plastic cable.

These devices are not to be used with aluminum wire.

Installing "boxes" in old buildings

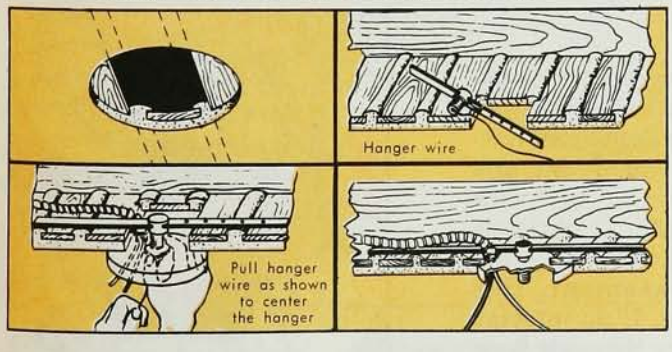
Switch and outlet boxes must be located between the studs, preferably at a spot 4 to 5 in. from the stud. Switches should be located about 48 to 54 in. above floor, convenience outlets about 12 to 18 in. above floor, or slightly above table height in kitchen and dining room. Wall light fixture outlets should be 66 to 70 in. above floor. Always place switches at opening side of door, not on hinged side. Use large size, 2½ in. deep, boxes if possible.



Follow steps illustrated above for installing boxes. If you fail to locate studs by sounding, drill every two inches until drill hits stud. Make small holes just above baseboard. Then determine location for box. Notch away plaster, as shown, to expose one full lath but only part of top and bottom lath. Use template to outline opening. Drill four ½-in. holes as indicated. Insert hacksaw in holes.

Draw saw toward you and hold hand or board against plaster to prevent cracking. Cut away center lath completely and half sections from other two. Then draw cable out of wall, attach connector —less locknut—and pull lead wires through knockout. Bring connector into place in box and tighten locknut. Final step is to anchor box securely to lath using No. 5 wood screws.

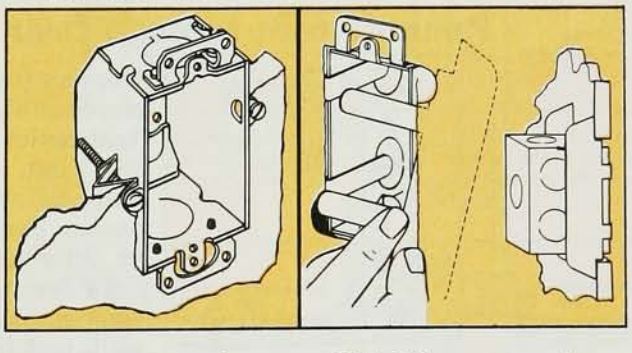
How to mount ceiling boxes



Where space is not accessible above the ceiling, the work must be done from below as indicated; (1) Notch away plaster to size of a shallow box and carefully cut away center lath; (2) Insert hanger (remove locknut and put wire throu

Hold stud above ceiling with one hand, pull wire with the other hand and hanger will center itself. (3) Connect cable to shallow box. Pull wire (from hanger) through center knockout and install locknut on threaded stud. Fourth view shows

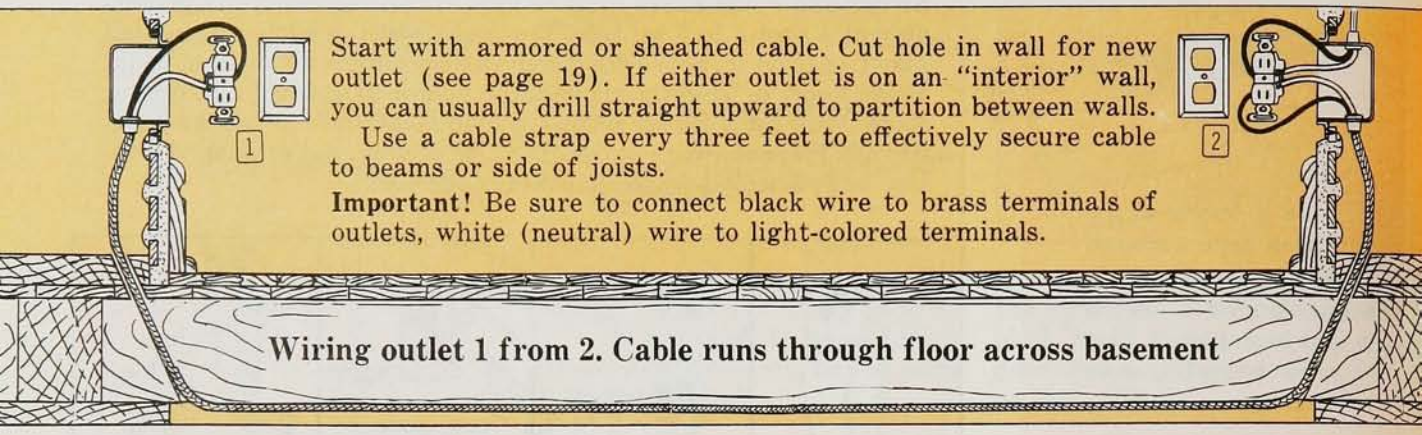
Special boxes for easier mounting



"Grip-Tite" box clamps quickly in place. See how easy it is to anchor box securely front and back (above). Push box with connected cable in opening so that front brackets fit against wall. Then tighten side screws to bring side brackets up snug against wall.

Metal box supports can assure a stronger job. Insert supports on each side of box. Work supports up and down until they fit firmly against inside surface of wall . . . bend projecting ears so they fit around box.

How to connect new outlets in old homes

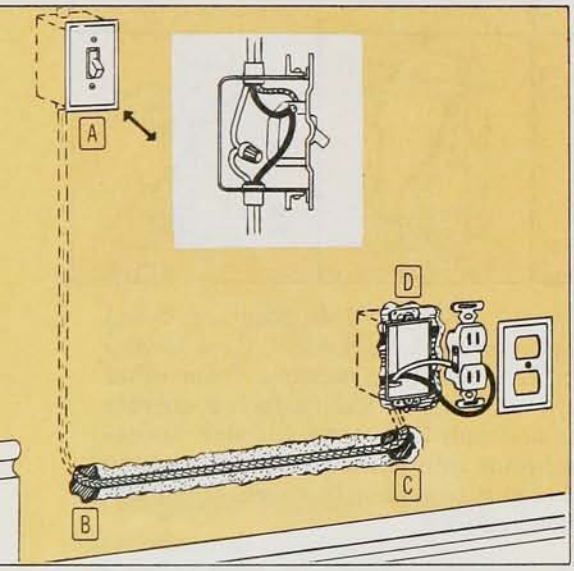


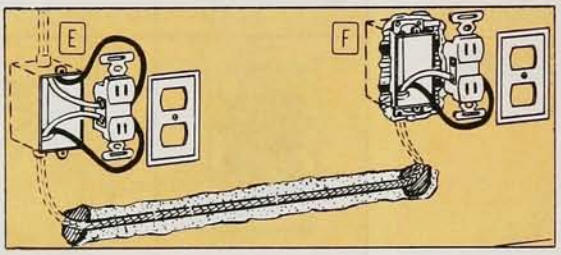
Start with armored or sheathed cable. Cut hole in wall for new outlet (see page 19). If either outlet is on an "interior" wall, you can usually drill straight upward to partition between walls.

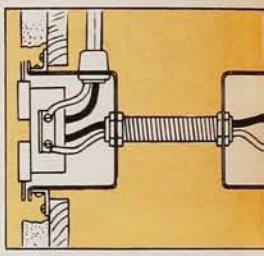
Use a cable strap every three feet to effectively secure cable to beams or side of joists.

Important! Be sure to connect black wire to brass terminals of outlets, white (neutral) wire to light-colored terminals.

Wiring outlet 1 from 2. Cable runs through floor across basement





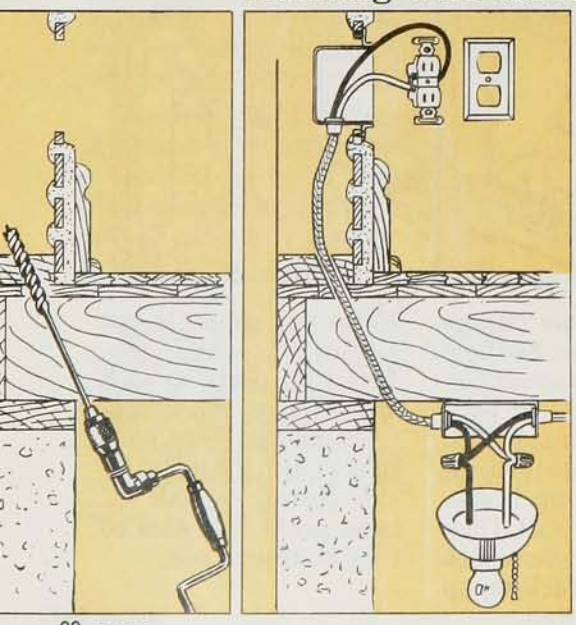


From wall switch to baseboard outlet (if neutral wire is available). First, cut hole in wall. Remove baseboard, cut holes B, C. Notch channel in plaster. Now remove knockout in switch box A. Attach a cable connector, Fish cable into knockout in A from B, then run through hole C to box D. Connect as shown.

Wiring from one outlet to another: Same, up to notching channel. Extend 2-wire cable from box E to new box F, groove cable, replace baseboard. Be sure! Black to black, white to white.

Wiring back-to-back outlets in adjoining rooms: Cut matching holes, wire with conduit or threaded nipple with locknuts.

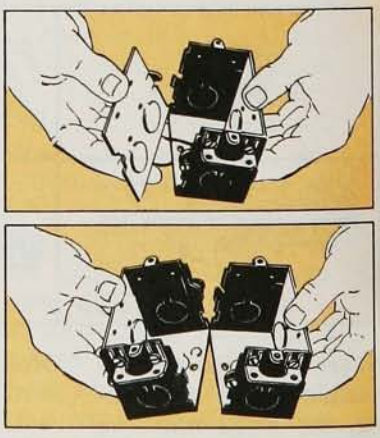
Running wire through floor



Use continuous length of armored or sheathed cable from light outlet to baseboard outlet. First, select outlet site and cut opening through plaster and lath. If outlet is on outer wall, bore diagonal hole from basement. Use long-shank bit. If on interior wall, just bore through floor to partition between walls.

By pushing a short length of fishwire up basement hole, and attaching wires to it, you pull wires through to outlet opening.

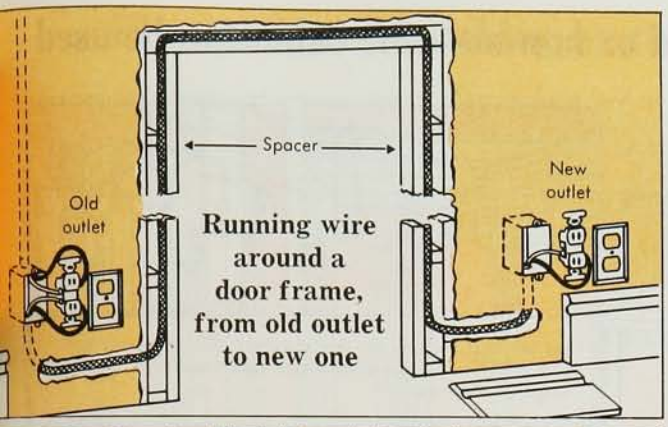
Now attach cable to boxes connecting as shown. Be sure! Connect black to brass-color, white to light-color!

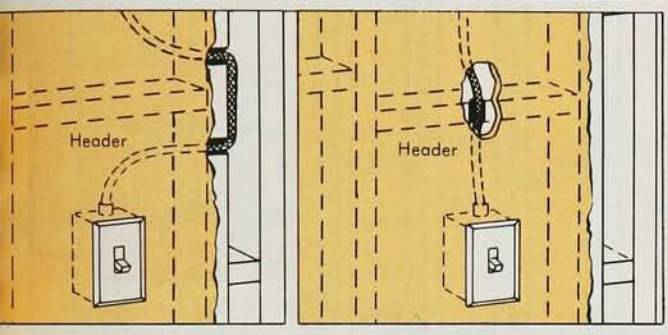


How to gang metal boxes

Metal switch boxes are built so that any number may be put together, or "ganged." Simply remove wall end of each box, fit boxes together, tighten screws. Applies only to metal.

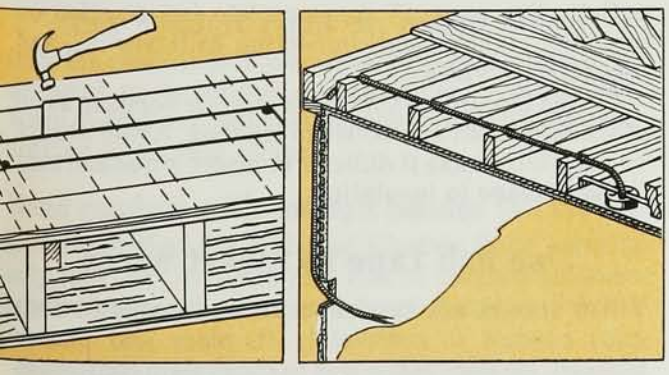
How to run cable inside walls and ceilings





Running cable around door frame headers

If you're planning to run a cable around door from present outlet to new one, here's the easy way. Remove baseboard and door trim. Notch wall and spacers between frame and jamb. If outlet is to be placed beyond first upright, use extension bit to drill past additional uprights. Wire and replace. Headers are not always found in partitions. If your wall has them, pass them as shown.



Attic installation . . lifting floor boards

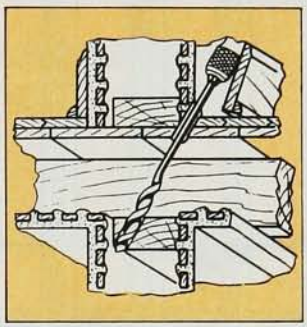
Where attic can be reached, the floor boards can be lifted, joists notched, and a hole bored with an electrician's bit through obstructions. If attic is inaccessible, but cable can be run parallel with floor beams or joists, connect ceiling outlets with wall switches by drilling as shown at right. Draw cable through the opening using fish wire. Where cable runs across beams, floor boards must be lifted.

If you are beginning a project of wiring or rewiring an existing building, here are a few helpful tips. Carefully study the hints on carpentry and building construction outlined here. They'll make your job easier.

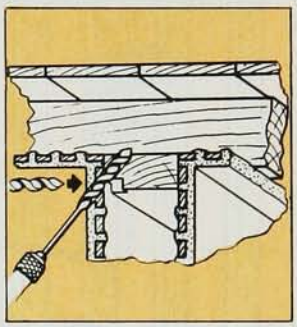
Use non-metallic sheathed cable, dual-purpose plastic cable or armored cable on these jobs. They can be drawn between walls, ceilings or floors without disturbing construction.

Final tip: when replacing floor or wall boards, be careful: *don't* drive nails through cable.

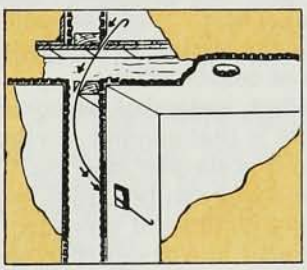
HOW TO "FISH" A WIRE



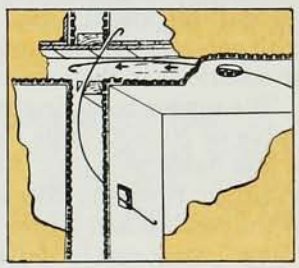
If you can get into attic or upper room, simply remove the upstairs baseboard. Then drill diagonal hole downward as shown.



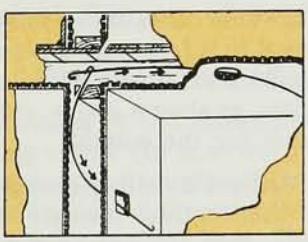
Drill diagonal hole upward from opposite room. Then drill horizontally till holes meet. This method requires patching plaster.



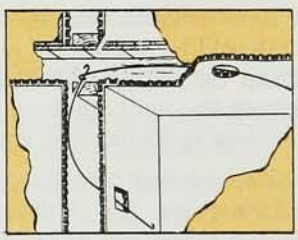
Push 12-foot fish wire, hooked at two ends, through hole on 2nd floor. Pull one end out at switch outlet on 1st floor.



Next, push 20-25-foot fish wire, hooked at both ends thru ceiling outlet (arrows). Now fish until you touch the first wire.



Then withdraw either wire (arrows) until it hooks the other wire; then withdraw second wire until both hooks hook together.

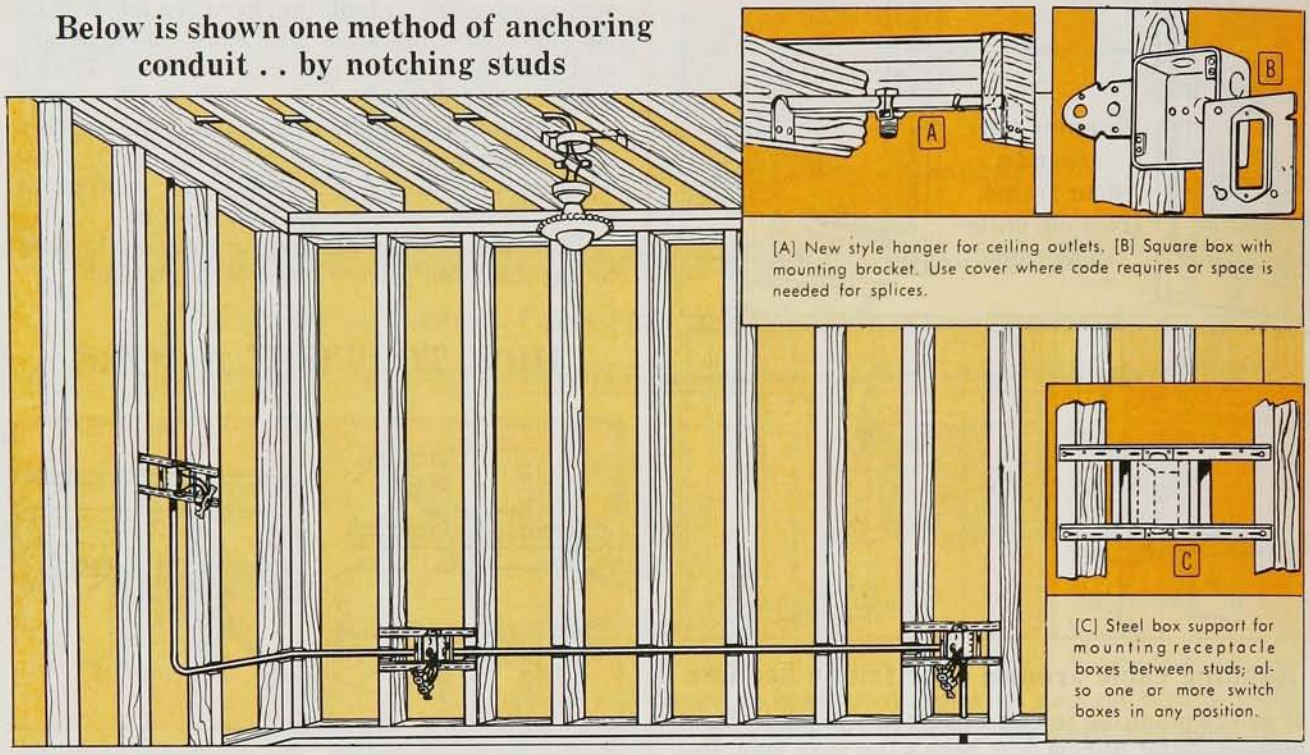


Lastly, pull shorter wire thru switch outlet. When hook from long wire appears, attach cable and pull thru wall and ceiling.

When wiring a new home or addition

Conduit wiring preferred but armored or non-metallic cable can be used

Below is shown one method of anchoring conduit . . by notching studs



[A] New style hanger for ceiling outlets. [B] Square box with mounting bracket. Use cover where code requires or space is needed for splices.

[C] Steel box support for mounting receptacle boxes between studs; also one or more switch boxes in any position.

Use latest type steel boxes, supports and hangers

In many localities, particularly in cities and towns, regulations specify that all "new" work be done with conduit. (New work is the wiring of buildings or additions in the process of construction).

The reason for using conduit, instead of Armored Cable or Non-Metallic Cable is that conduit wiring is less liable to injury. Also it is simpler later on, to do minor rewiring because wires can be pulled out of the conduit and larger ones installed if necessary. "New" work can be done faster and easier than old work.

In "new" work the conduit run is put into place before the house is completely built. Then, after house is finished and walls plastered, wires are run through the conduit and connected to switches and outlets. See page 17 for complete information on handling conduit and connecting to boxes . . . and insertion of wires.

Do not have more than four quarter bends in a run of conduit from one outlet to another. Avoid abrupt bends which make it difficult to insert wires and may cause damage to insulation.

Always anchor conduit securely

Where conduit runs along the side of a stud or joist it should be supported every 6 to 8 feet with a pipe strap or clamp. Where conduit runs horizontally across the wall studs or joists, as shown above, cut notches to provide a channel for the conduit.

For conduit installation without notching see opposite page. Many prefer this method because it does no damage to studs.

Wires must be continuous from outlet to outlet. Do not use spliced wires. Pull or junction boxes shall be located so that they are easily accessible at all times.

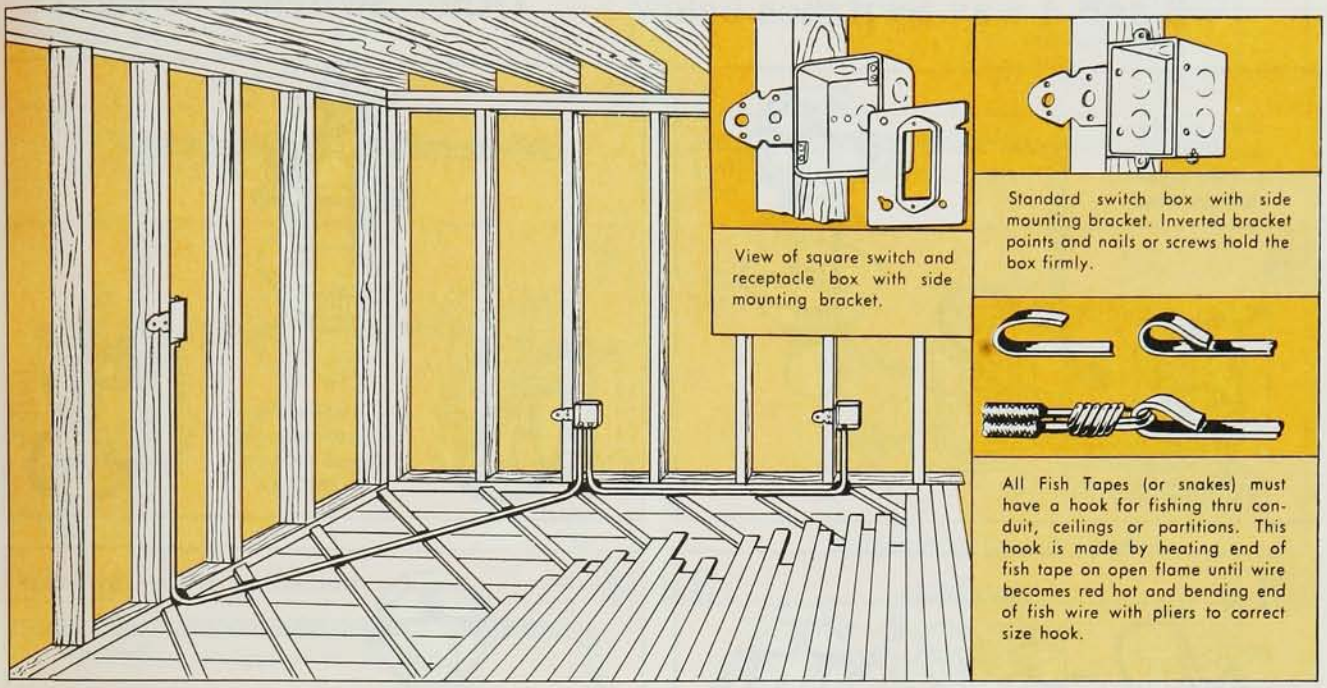
Use fish tape to insert wires

Wires should not be drawn through conduit runs until conduit is completely in place and plaster finished. Be sure that wires in the system conform to the standard color code . . . in a 2-wire circuit, one black and one white wire . . . in a 3-wire circuit, one black, one white and one red.

Where the run is long and several wires are to be inserted in conduit, fish tape will be needed. It comes in 50 and 100 foot lengths. In straight runs tape moves smoothly. To go through bends work tape back and forth until bend is passed. Use soapstone or talcum powder as a lubricant. On short runs wires can be pushed through.

follow these practices for a first-class job

Eliminate stud notching by running conduit across sub-floors



View of square switch and receptacle box with side mounting bracket.

Standard switch box with side mounting bracket. Inverted bracket points and nails or screws hold the box firmly.

All Fish Tapes (or snakes) must have a hook for fishing thru conduit, ceilings or partitions. This hook is made by heating end of fish tape on open flame until wire becomes red hot and bending end of fish wire with pliers to correct size hook.

Thin-wall conduit installation on rough floor saves time

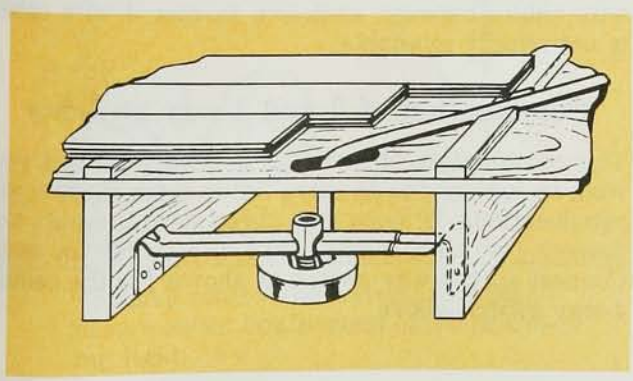
There is no need to notch the upright studs when thin-wall conduit is installed as shown above. This gives you a better installation because it does not weaken supporting studs for ceiling and upstairs and it also cuts down on work. The only carpentry is a small notch in plate, as shown.

Lay conduit right on rough floor

Once the conduit is in place install furring strips (or sleepers) up to conduit and continue to rough wall. When rooms are finished or plastered nail finished flooring to furring strips.

Bend conduit with conduit bender (P. 17, 30)

Remember that the National Electric Code permits only four 90° bends in any run of conduit between any two boxes. See opposite page for wire fishing.



Use steel switch and outlet boxes only in conduit installations. Be sure edges of boxes are far enough out from the lath so that they can be lined up level with the plaster line. Also be sure that switch boxes are mounted so that there will be at least a 2 in. clearance from any door frame.

Check wire capacities of conduit

The size conduit you use in any given run depends on the number of wires, and size of wires, you plan to pull through conduit. See pages 17 and 40 for full information. Also check local Code.

Additional points to remember

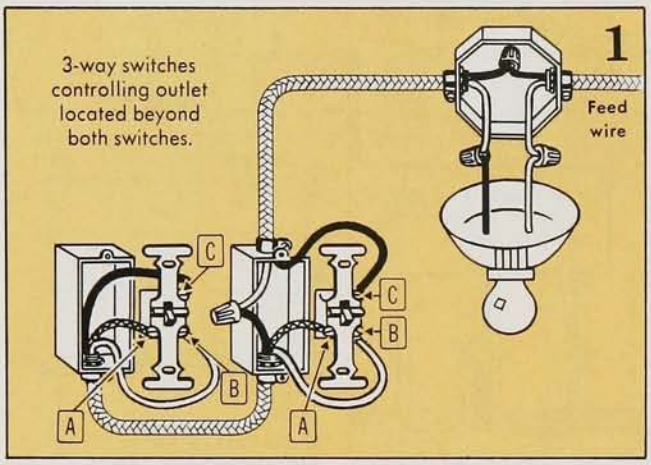
All empty conduit runs should be mounted in place and connected to boxes before any wires are inserted. See page 17 for further information.

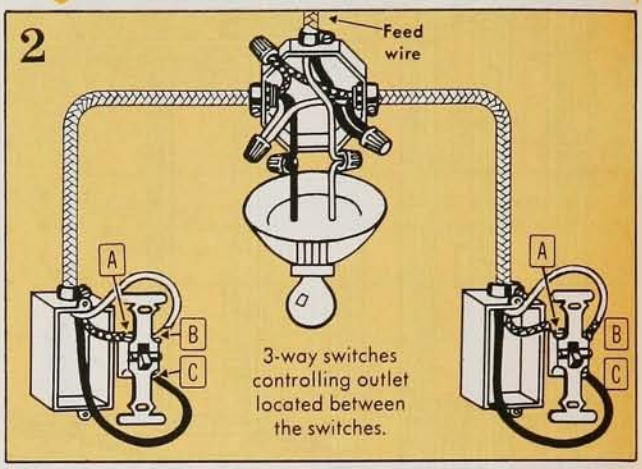
Installation of ceiling outlets

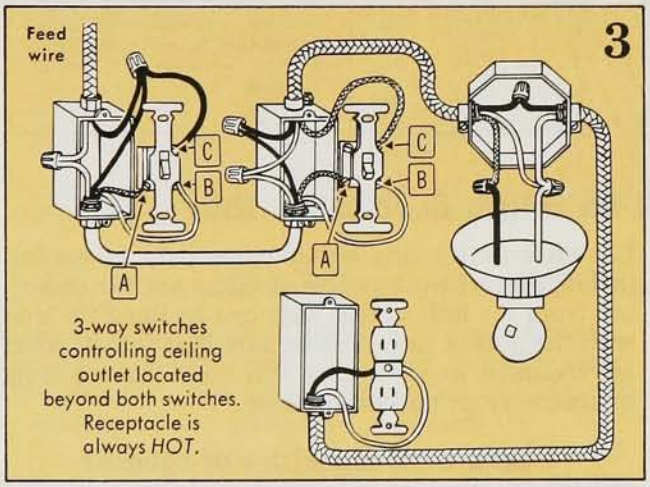
Illustration at left shows how conduit is installed to a ceiling outlet (in new work) where a finished floor is being installed overhead. Drill two holes about 6 inches apart in line of direction of conduit. Cut out between holes with keyhole saw. This slot is necessary to accommodate the radius of the bend in the conduit. Use type of hanger shown and nail hanger to joists before connecting conduit. Be sure outlet sets level with bottom edge of plaster.

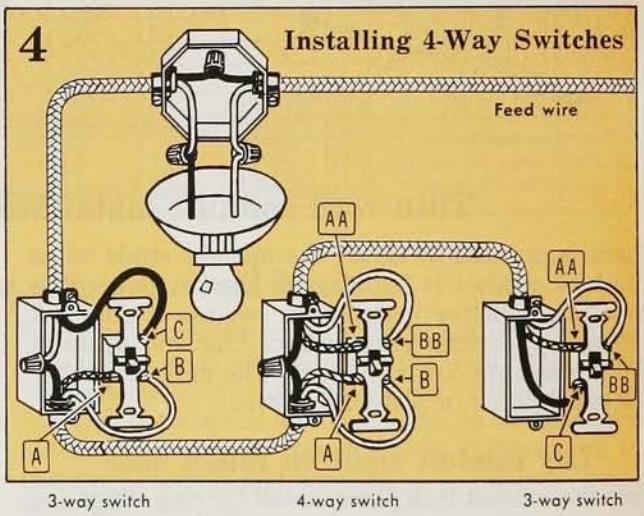
Wiring diagrams for Switches

3 and 4-way Switches below — Other Switches at right









NOTE: In all cases, the white wire from switches must be painted black, both at the switches and at light outlet.

3-way switches are most frequently used to control one or more lights from two different points so that light can be turned on or off by either switch. For example; in a long corridor or large room with entrances on opposite sides, or at top and bottom of a stairway so that light can be turned on as you start up stairway and off when you reach the top. Helps avoid fumbling in dark.

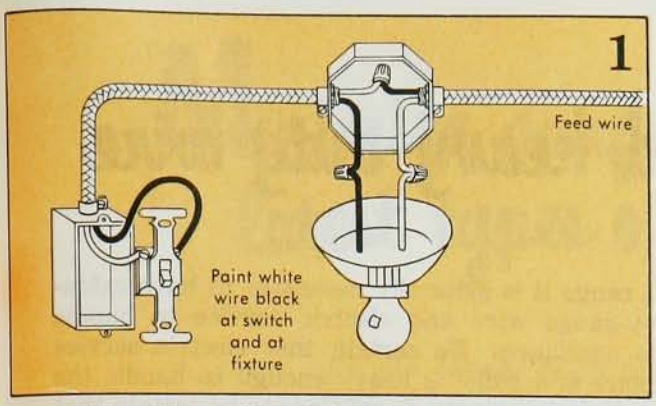
Follow diagrams above when connecting 3-way switches. Just be sure to connect the black, white and red wires as shown. In all cases, the terminals marked A and B are the light-colored terminals to which red and white wires must be connected. Terminal C, in all cases, is the dark colored terminal to which the black wire must always be connected. Check diagrams carefully. Regardless of location of terminals, always connect wires to brass terminals and dark terminal as noted above.

You will notice that 3-wire cable is required for some of the runs from box to box. In all cases the white wire from the switch must be painted black at the switch and at light outlet.

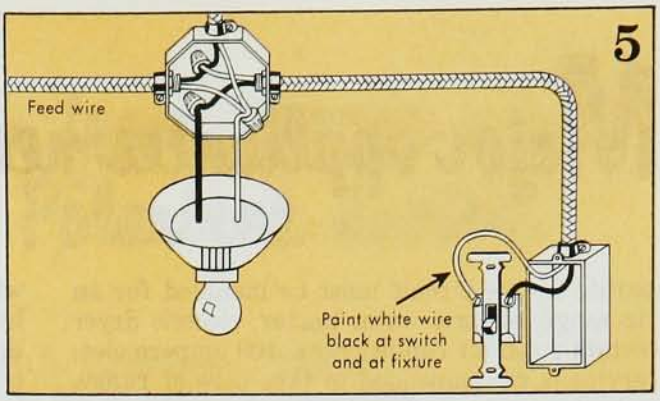
In illustration (number 3) you can use two 2-wire cables between switches, in case 4-wire cable is not readily available.

Combination of 3 and 4-way switches

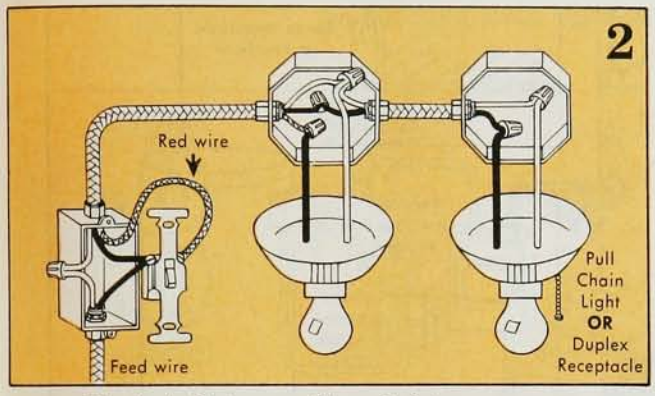
This combination of switches is used wherever you wish to control one or more lights from three separate locations. If more than three control points are desired, just use an additional 4-way switch for each. Connect each 4-way switch as shown for the center 4-way switch above.



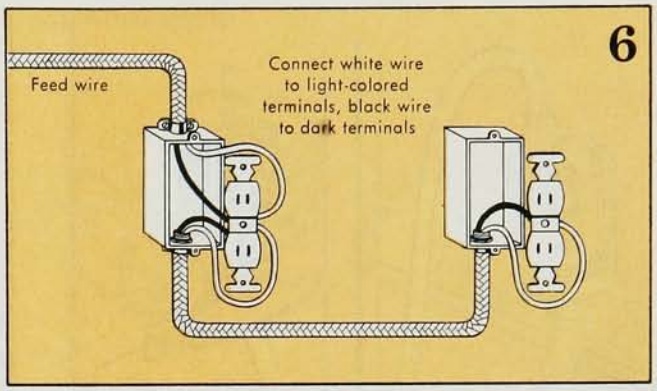
To add a wall switch to control ceiling light at end of run



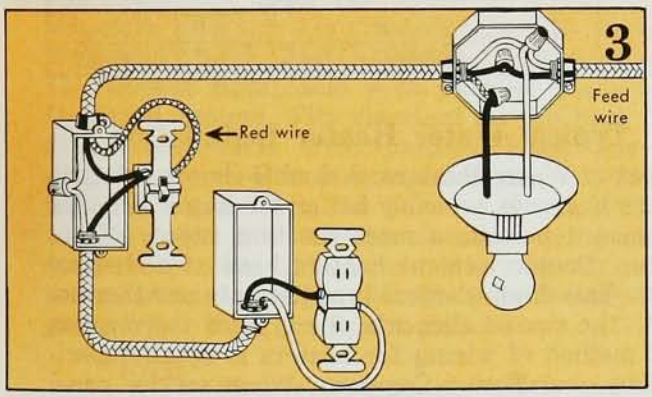
To add wall switch to control ceiling light in middle of run



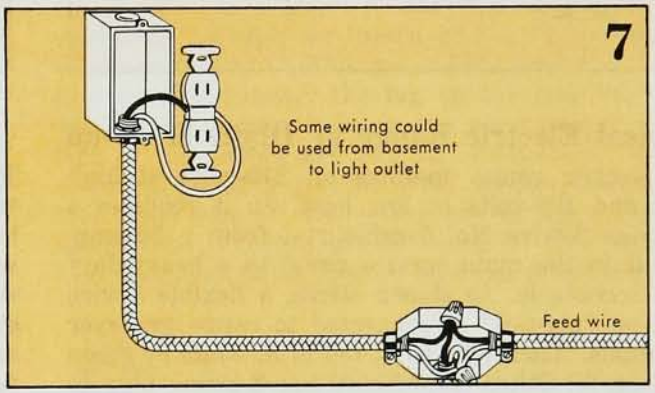
To install two ceiling lights on same line; one controlled by switch



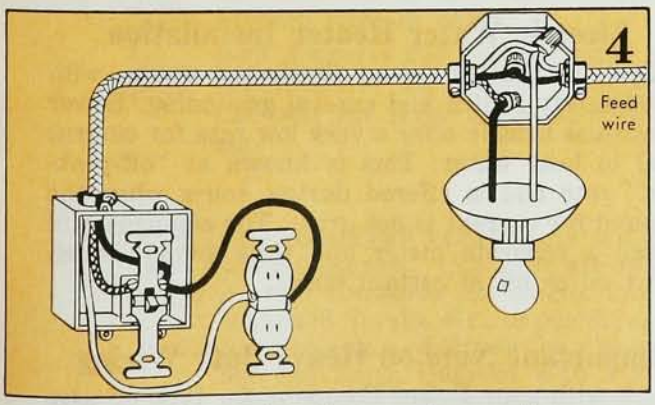
To add new convenience outlets beyond old convenience outlets



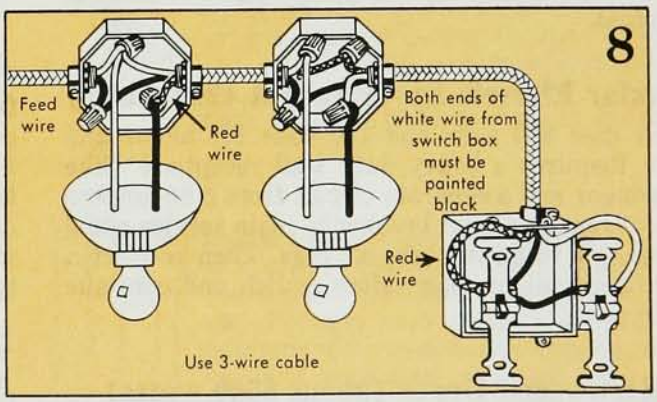
To add a switch and convenience outlet beyond existing ceiling light



To add a new convenience outlet from an existing junction box



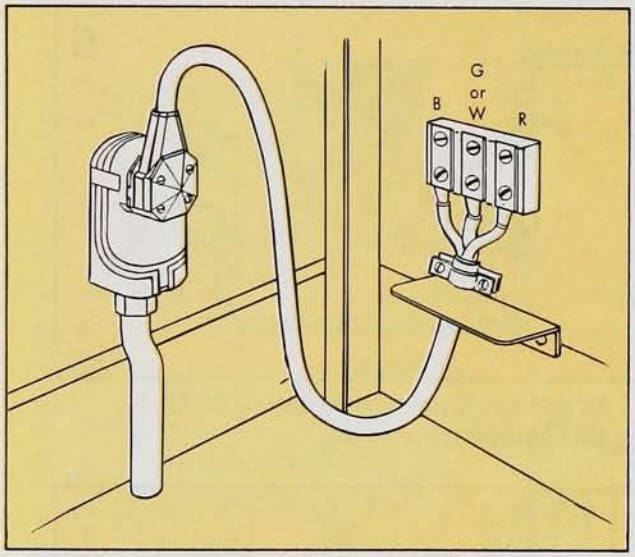
To add a switch and convenience outlet in one outlet box beyond existing ceiling light



To install one new ceiling outlet and two new switch outlets from existing ceiling outlet

Major appliances need heavy-duty wire

A separate 3-wire circuit must be installed for an electric range, electric water heater, electric dryer and certain room air conditioners. 100 ampere electric service is recommended to take care of range, water heater and regular dryer. However, when high-speed dryer (about 8500-w.) is connected along with range it is generally necessary to have extra-heavy-gauge wire and electric service to handle these appliances. Be certain that electric service entrance and panel is heavy enough to handle the load. *And:* check your Local Code to be certain that both wiring and grounding methods conform.



Typical Electric Range or Dryer Hook-up

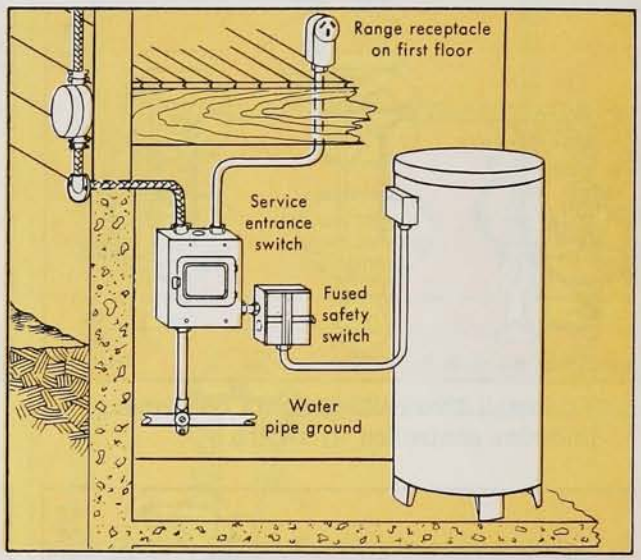
An electric range operates on 240-volts at high heat and 120-volts at low heat. So it requires a separate 3-wire No. 6 cable run from a 50-amp. circuit in the main service panel to a heavy-duty wall receptacle. As shown above, a flexible 3-wire cord or "pig-tail" is connected to range or dryer terminals. Black wire to B, red to R, white or green to G or W. Other end of cord has 3-prong plug to fit range or dryer receptacle. Use of cord and receptacle permits range to be disconnected easily. **Ground metal frame of range or dryer to neutral terminal.**

Regular Electric Dryer (about 4200 watts)

Dryer uses 240 volts and 120 volts for motor and light. Requires a heavy duty wall receptacle (like the range) and a separate circuit from a 30-ampere pullout fuse or circuit breaker in main service panel or connect to power take-off lugs. Then connect a fuse or circuit breaker safety switch and continue to dryer.

High-speed Dryer (about 8500 watts)

Installation is same as for dryer above except that it requires a 50-ampere circuit (also heavy-duty wall receptacle) the same as for range.



Typical Water Heater Installation

Types of Water Heaters. A double-element electric water heater is probably better for larger families because it permits a more constant supply of hot water. Double element heaters have two thermostats. The single-element type has only one thermostat. The size of elements, the type of thermostats and method of wiring for heaters is usually specified by your Power Company. When service panel has unfused tap for heater, use an indoor safety switch.

Electric Water Heater Installation

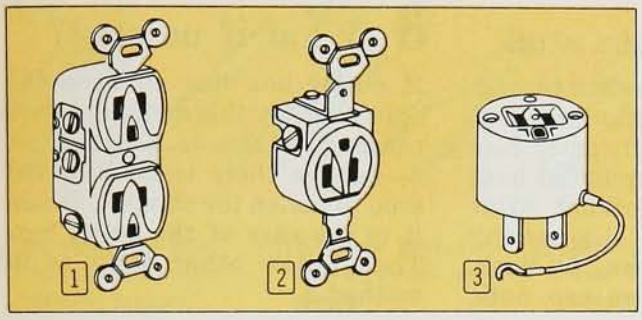
Follow installation set-up illustrated above, with fused safety switch and careful grounding. Power companies usually offer a very low rate for current used to heat water. This is known as "off-peak-load" rate and is offered during hours when the demand for current is not great. The company will install a separate meter and time switch which turns on or off at certain hours.

Important Note on Heavy-duty Wiring

Check with your Power Company for type of wire specified by local Code. In many areas service entrance cable is used and the uninsulated wire is connected to neutral terminal on range or dryer.

Minimize danger from shocks with latest types of Polarized devices

All the devices below meet UL requirements. Each has 2 current-carrying contacts plus one grounding contact. They guard against dangers from current leakage due to faulty insulation or exposed wiring, help prevent accidental shock. Install in kitchens, basements, workshops, garages. Or use on portable tools, appliances, extension lights.

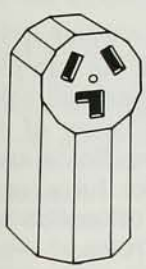


UL Listed 3-wire devices

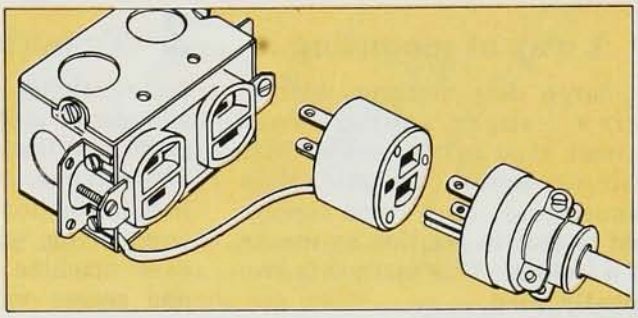
For equipment using *120 Volts—15 Amperes or less,* such as small Air Conditioners, Gas Dryers, Washers, Power Tools, Garden equipment, etc. (1) Duplex Receptacle with parallel Blade and U shaped ground. Fits standard switch box. (2) Single Receptacle with parallel blade and U shaped ground. Fits standard switch box. Green terminal connects to the bare or green covered wire in cable. (3) Adapter for converting standard receptacles to accommodate new style attachment cap with parallel Blade and U shaped ground. See right for hook-up to box.

Single receptacle with tandem blades and U-shaped ground, are available in two sizes. Green terminal connects to the bare or green covered wire in cable.

0-15 Amperes 240 volt for small air conditioners, etc. *21-30 Amperes 240 volt* for large air conditioners, etc.



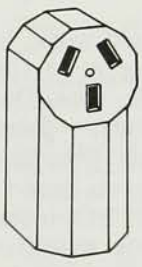
Surface-type receptacle with L shaped ground. Cord sets are available to complete the connection to standard dryers, etc., to permit easy disconnecting of dryer for cleaning and servicing. Connect with 3 wire cable. For equipment using *120/240 volts—30 amp. or less.*



Conversion from 2-wire to 3-wire

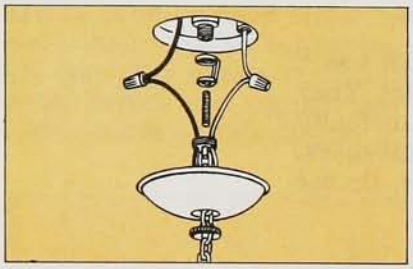
Here's how to convert a standard receptacle by using the adapter as shown above. If the wires which connect to outlet are run in conduit or armored cable connect the lug on the lead wire to one of the screws holding the receptacle to the box. If the wires are run in non-metallic cable which has a bare ground wire, connect the lug to this bare wire. If the wires are in non-metallic cable without a bare ground wire, be sure to connect lug to suitable ground such as a water pipe.

Single receptacle with horizontal and vertical blade with U-shaped ground. Fits standard switch box. Uses single receptacle plate. For equipment using *240 volts—20 amp. or less,* such as larger air conditioners, power tools, garden equipment, etc. Green terminal connects to the bare or green covered wire in cable.



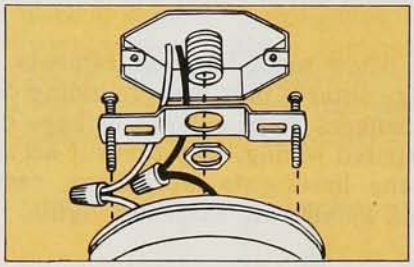
Surface-type receptacle. Cord sets are available in different lengths for connection to high-speed dryers, ranges, etc. Permits easy disconnection of equipment when redecorating, cleaning and servicing. Connect with 3 wire cable. For equipment using *120/240—50 amp. or less.*

How to install typical lighting fixtures ..only 3 simple steps usually required



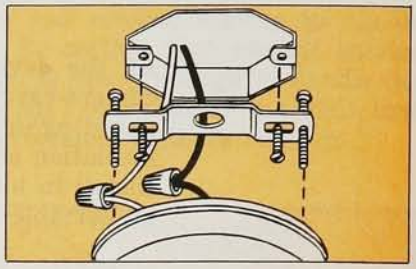
1 A way of mounting . .

. . large drop fixtures. Simply screw hanger support onto thread stud in the outlet box. Connect wires (use solderless connectors), then raise canopy and anchor in position by means of a locknut. This method is frequently used.



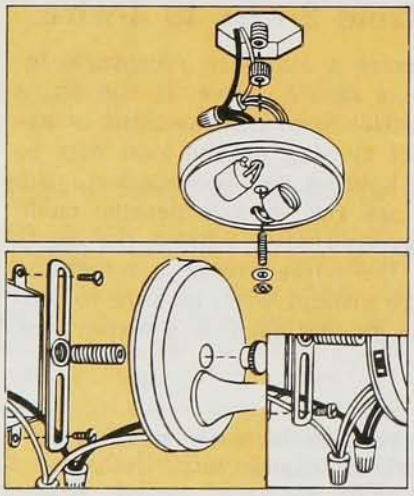
2 To outlet box stud

Insert machine screws in threaded holes of metal strap as shown by dotted lines. Slip center hole of strap over stud in outlet box; hold in position by locknut. After connecting wires, slip canopy over machine screws, fit flush, and secure with two cap nuts.



3 What if no stud?

If outlet box has no threaded stud, then try this method. Insert the machine screws, as in method 2—but, as there is no threaded stud to fasten the strap to, fasten it to the ears of the outlet box. Then follow other steps as in method 2.

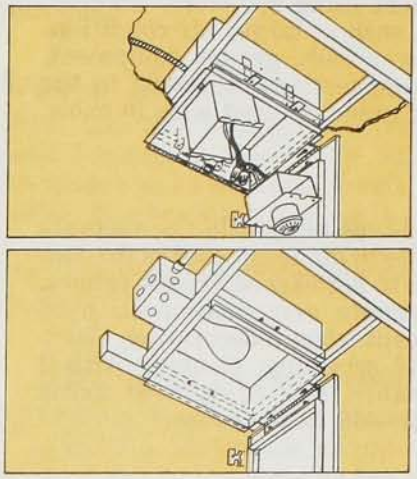


Attaching glass enclosed ceiling fixtures

Glass enclosed fixtures can be installed in the ways previously shown, when there is a threaded stud provided in the outlet box. You merely attach the brass adapter (or cap) to the stud. Then connect the wires: insert threaded nipple through the center hole in the fixture and screw into adapter until tight. Then fasten fixture with locknut.

Installing wall lights

Most wall lights are installed by strapping to the ears of the box, then using nipple and cap nut to fasten fixture to strap. If light has an "always-on" convenience outlet, connect as shown in the small diagram. Remember to **always** connect black to black and white to white.



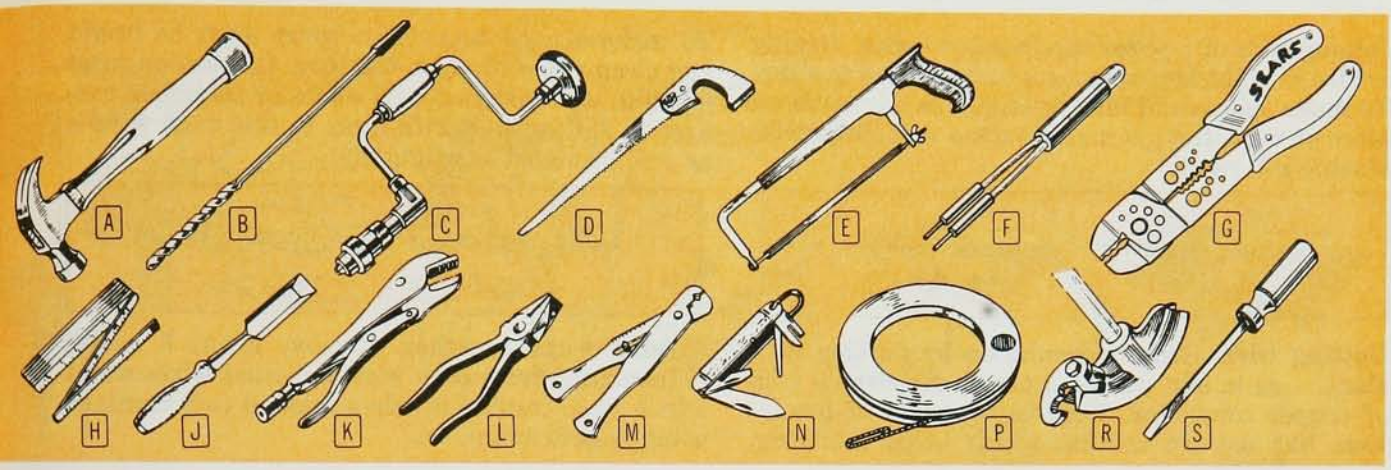
Recessed fixtures in OLD and NEW work

In old work, locate joints by tapping or drilling, then probing with wire. Outline space for box *between* joists. Then saw out. Next, provide support for mounting, as wood strips laid across lath, and insert the box, securing it by mounting brackets or by screws into joist or wood strips.

In new work, it is simpler. Mount box with clearance below joist equal to thickness of the ceiling to be applied. Some areas require that fixture have separate junction box; others do not. Check your Local rules.

Full kit of Electrician's Tools

Speed work and quality of jobs



A **Hammer.** For driving staples, nails, fastening hangers.

B **⅝ inch Bit or Drill.** For boring wood or soft metal.

C **Bit Brace.** For use with drill, screwdriver, reamer.

D **Keyhole Saw.** For cutting circles and shapes.

E **Hack Saw.** For cutting cable, plaster or laths.

F **Test Light** to trace circuits, test fuses and lines.

G **Multi-purpose tool.** Cuts and skins wire, attaches terminals, etc.

H **6-foot Folding Rule.** For measuring wire, openings.

J **Chisel.** For notching studs, joists, plaster, flooring and lath.

K **Lever-jaw Wrench.** Use as plier, lock wrench, pipe wrench.

L **Linesmen's Pliers.** For gripping locknuts, cutting wires.

M **Wire Cutter, Stripper.** For details, turn to page 31.

N **Jack Knife** for cutting insulation.

P **Fish Tape and Reel**—fish wire thru wall and conduit.

R **Conduit Bender.** A handy time-saver.

S **Screwdriver** to tighten screws, locknuts.

Explanation of Standard Electrical Terms

A Volt is the unit used in measuring *electrical pressure* (like pounds in a water system).

An ampere is the unit used in measuring electrical *rate of flow* (like gallons per minute in a water system).

A Watt is the unit which shows current drain with *both* voltage and amperage considered. For example:

1 Ampere at pressure of 1 Volt = 1 Watt.
1 Watt used for 1 Hour = 1 Watt Hour.
1000 Watt Hours = 1 Kilowatt Hour (Kwh.) which is the unit by which electricity is metered.

Horse-power—One HP equals 746 watts.

Circuit—Two or more wires through which electricity flows out from the source of supply to one or more outlets, and then back.

Switch—A device for breaking the flow of current.

3-way Switch—A type used in pairs to control the same light from two different points (see page 24).

Outlet—A device that permits tapping off electricity at convenient locations for lights or appliances.

Receptacle—A type of outlet to which electric cords can conveniently be plugged in.

Fuse—A safety device which breaks the flow of electricity whenever a circuit becomes overloaded.

Circuit-breaker—Performs the same function as a fuse in the "Circuit-Breaker" types of service panel.

Electric Service Panel—The main panel (or fuse cabinet) through which electricity is brought into the building and then distributed to various branch circuits. Contains the main disconnect switch for the entire wiring system, as well as fuses or circuit-breakers.

Conductors—Common trade term for electric wires.

Grounding—The connection of the electrical system to the earth, a precaution necessary to prevent damage from lightning and minimize danger from shocks.

"Hot" wires—The power-carrying wires (usually black or red) as distinguished from the "neutral" wires (usually white).

Insulation—A protective sheathing used over wires to prevent escape of electricity.

"Color-Coding" or Polarizing—Identification of wires by color throughout the system to help assure that "hot" wires will be connected only to "hot" wires and that "neutral" wires run in a continuous uninterrupted connection back to the ground terminal.

Alternating current—The type of power used in all farm and home wiring systems. Usually 60 cycles, but 25 and 50-cycle systems are used in a few localities and countries outside U. S.

Short circuit—An improper connection between "hot" wires or between a "hot" wire and a "neutral."

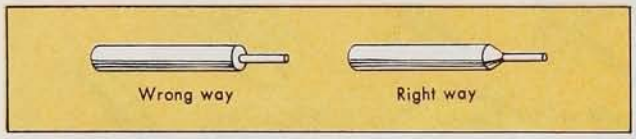
Underwriters' Laboratories—A nationally accepted organization which tests all types of wiring materials and devices to make certain that they meet minimum standards for safety and quality. Be sure to look for the Underwriters' tag or stamp on every piece of wiring material you buy. Don't take chances with inferior materials which have not been listed by Underwriters.

"Voltage drop"—A term used to indicate the voltage loss which occurs when wires are overloaded. Always make sure that any wires you install are of sufficiently heavy gauge to efficiently carry the electrical load for all appliances to be connected to them.

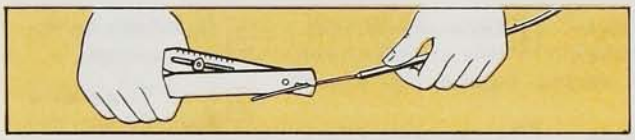
How to cut, splice, connect wires

Solder all splices and taps *except* where you use solderless connectors!

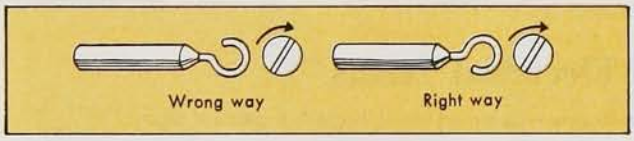
Joining ends of 2 wires together is a splice. Joining a wire at right angles to a continuous wire is a tap. To make splices and taps as strong as a continuous piece of wire, the job must be done well. Otherwise trouble will result.



Cutting wire. Remove insulation by cutting at a slant . . as in sharpening a pencil. Expose ½ inch of copper conductor. Remove all parts of insulation, but not tin coating which helps soldering.

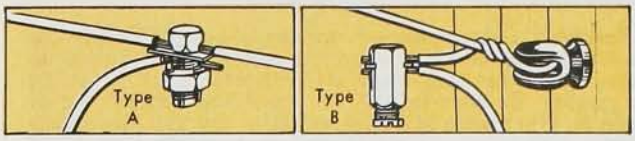


Combination Wire Cutter and Stripper. Makes a handy tool that cuts and strips clean all sizes of solid or stranded copper wire. Use also for looping wires under screws.



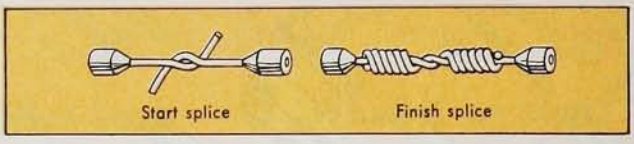
Connections at screw terminals. Bend end of metal wire into a loop to fit around screw. Be sure to attach loop in direction in which screw turns when tightening as illustrated above.

Applying solder. So solder will flow easier, first coat wires with electric soldering paste. With soldering iron, heat wires until solder melts and flows into every crevice.

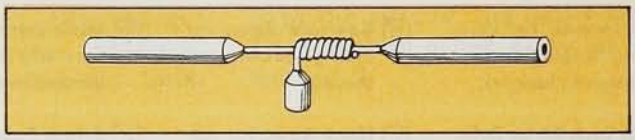


On runs to buildings and to power feed lines use solderless connectors. Type A taps an existing line with strain on wires. Use Type B for electric service connections. Insulate with plastic tape.

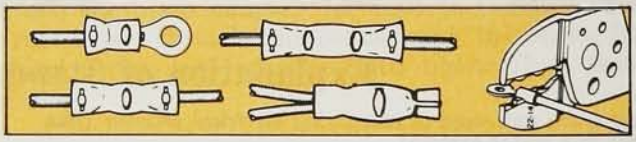
To make a good connection wires must be bright and clean when brought together. Connection must be tight, well fastened with solder or solderless connectors and covered with tape. In this way, wire is as well insulated as originally.



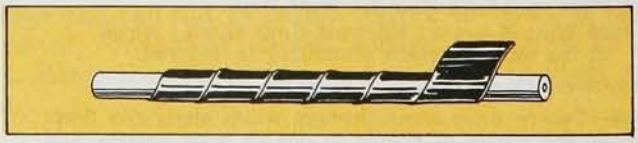
Splicing wires together. Remove about 3 inches of insulation from each wire and cross wires about 1 inch from insulation; then make 6 to 8 turnings using fingers and pliers.



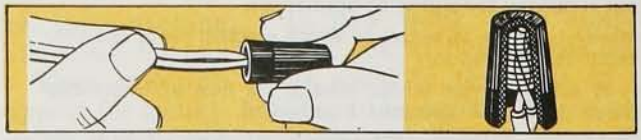
Tap splices. For connecting the end of one wire at a point on a continuous wire. Use only if there is no pull on tapped wire. Bare and clean tap wire, then wrap around continuous wire. Solder, tape.



Solderless Terminals. Plastic insulation is permanently bonded to the terminal . . . cannot slip off or be removed. Install with one quick stroke of Sears Multi-Purpose Tool (see opposite page—Fig. G).



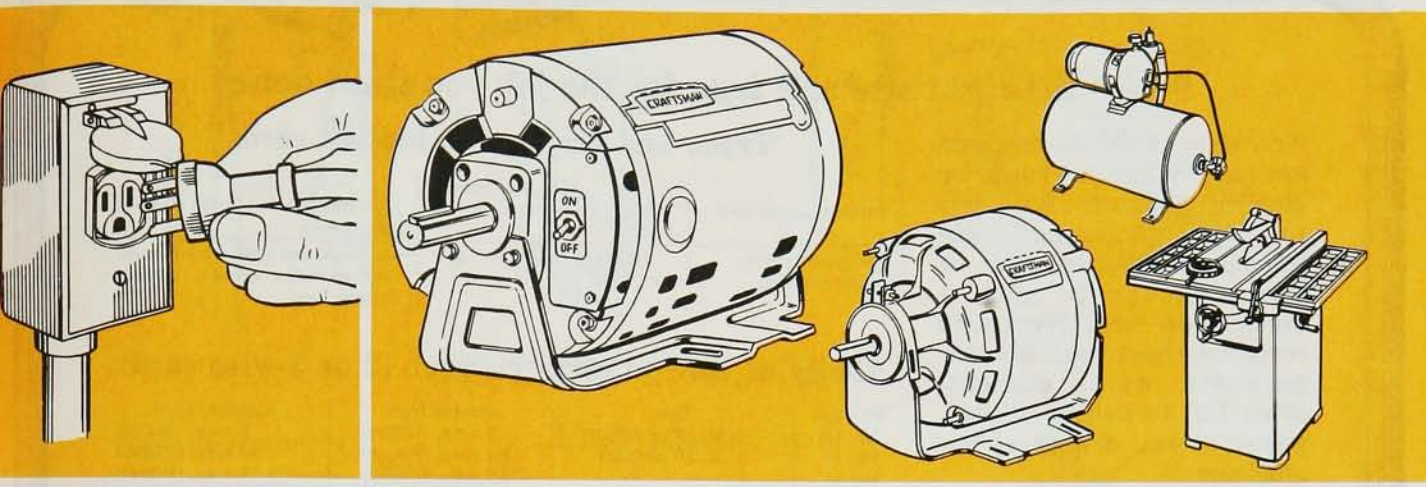
Plastic Tape does a faster, neater, cleaner job than rubber and friction tape. Easier to handle takes less space in boxes. Does the work of both rubber and friction tape. Water-proof, acid-proof.



Solderless connectors eliminate the need for soldering joints. Made of insulating material so wires need not be taped . . . short circuits can't occur. Just screw connector over wires as shown.

How many Electric Motors in your future?

Arrange heavy-duty circuit and outlets with needs in mind



Electric motors for power, ease, long service

It doesn't take a crystal ball to know that more and more farm, home and shop work will be taken over by electric motors. That's why proper planning today can save you hours of unnecessary future inconvenience. Provide enough outlets for motorized heavy-duty jobs . . grinding feed, pumping water, many others. Use 240-volt circuits to avoid wasting power (costs money!), excessive cost of heavier wire, annoyance of overload.

Heavy jobs demand large motors. Don't overload continuously—it's harmful. Get the HP you need. Don't try to get a steady 2 HP from a 1 HP rated motor.

For safety, install starting and stopping switches in the most accessible locations. If you need extension cords, be sure they're number 14 wire or better. *Never* use ordinary lamp cords for a motor.

Large motors demand 240-volt service

. . to reduce voltage drop, which causes motor to labor and overheat. Generally any electric motor of less than ½ HP can be plugged into a 120-V outlet, but provide 240-V for larger types. On 240-V, a ½-HP motor draws 3½ amps. Be sure wiring is heavy enough for this. And plan outlet sites carefully!

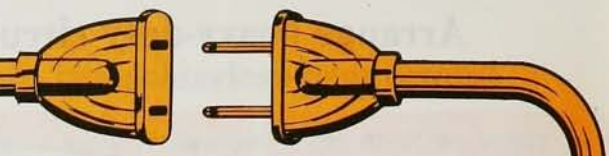
Find the correct-size wire you need

To determine correct-size wire for portable and permanent motors, (1) check distance from main switch to motor, (2) check size of motor and (3) check table below to determine the exact size wire you need.

Circuit Wire Sizes for Individual Single-phase Motors

Horsepower of Motor	Volts	Approximate Starting Current Amperes	Approximate Full Load Current Amperes	LENGTH OF RUN IN FEET from Main Switch to Motor							
				Feet	25	50	75	100	150	200	300	400
¼	120	20	5	Wire Size	14	14	14	12	10	10	8	6
⅓	120	20	5.5	Wire Size	14	14	14	12	10	8	6	6
½	120	22	7	Wire Size	14	14	12	12	10	8	6	6
¾	120	28	9.5	Wire Size	14	12	12	10	8	6	4	4
¼	240	10	2.5	Wire Size	14	14	14	14	14	14	12	12
⅓	240	10	3	Wire Size	14	14	14	14	14	14	12	10
½	240	11	3.5	Wire Size	14	14	14	14	14	12	12	10
¾	240	14	4.7	Wire Size	14	14	14	14	14	12	10	10
1	240	16	5.5	Wire Size	14	14	14	14	14	12	10	10
1½	240	22	7.6	Wire Size	14	14	14	14	12	10	8	8
2	240	30	10	Wire Size	14	14	14	12	10	10	8	6
3	240	42	14	Wire Size	14	12	12	12	10	8	6	6
5	240	69	23	Wire Size	10	10	10	8	8	6	4	4
7½	240	100	34	Wire Size	8	8	8	8	6	4	2	2
10	240	130	43	Wire Size	6	6	6	6	4	4	2	1

Extension Cords need proper care



Select the right size and type for the job you want done

Nos. 16 or 18 extension cords are usually fine for lamps or smaller appliances. But cords for heavy motors and high-wattage appliances must be heavy enough to carry a much larger load. Overloaded cords overheat (can be dangerous!), waste current, often fail to deliver enough power to run motors at top efficiency.

Types and usage of extension cords

	Type	*Wire Size*	*Use*
Ordinary Lamp Cord	POSJ SPT	No. 16 or 18	In residences for lamps or small appliances.
Heavy-duty—with thicker covering	S, SJ or SJT	No. 10, 12, 14 or 16	In shops, and outdoors for larger motors, lawn mowers, outdoor lighting, etc.

Ability of cord to carry current (2 or 3-wire cord)

Wire Size	*Type*	*Normal Load*	*Capacity Load*
No. 18	S, SJ, SJT or POSJ	5.0 Amp. (600W)	7 Amp. (840W)
No. 16	S, SJ, SJT or POSJ	8.3 Amp. (1000W)	10 Amp. (1200W)
No. 14	S	12.5 Amp. (1500W)	15 Amp. (1800W)
No. 12	S	16.6 Amp. (1900W)	20 Amp. (2400W)

The meaning of "Voltage Drop"

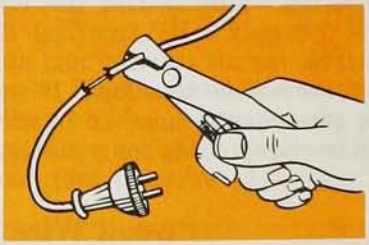
Every size wire has a maximum allowable current carrying capacity (see right). *But*—the longer the length of extension cord used, the greater the current loss or "voltage drop." Long runs of cord waste current, reduce efficiency of the appliance in use. Moral: it is *always* a good idea to plan a wiring system with plenty of convenient outlets. This will provide for easy plug-in of all appliances.

Selecting the length of cord set

Light Load (to 7 amps.)	*Medium Load (7-10 amps.)*	*Heavy Load (10-15 Amps.)*
To 25 Ft.—Use No. 18	To 25 Ft.—Use No. 16	To 25 Ft.—Use No. 14
To 50 Ft.—Use No. 16	To 50 Ft.—Use No. 14	To 50 Ft.—Use No. 12
To 100 Ft.—Use No. 14	To 100 Ft.—Use No. 12	To 100 Ft.—Use No. 10

NOTE: As a safety precaution be sure to use only cords which are listed by Underwriters' Laboratories. Look for the Underwriters' seal when you buy

What to do about damaged cords and how to repair them



You've undoubtedly met cord-jerkers. Yanking a cord out of a wall-plug by force, rather than grasping the plug itself, can loosen connections or even break the wires. Rough handling is probably the greatest single cause of extension cord mortality.

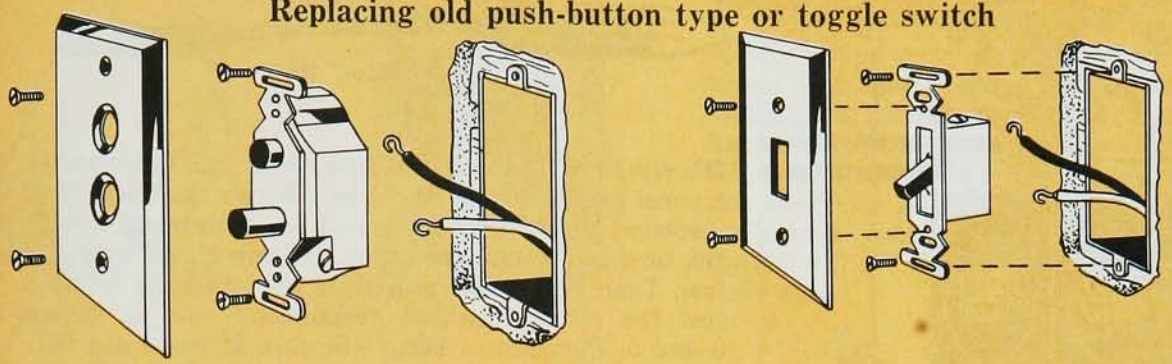
Damaged cords are a fire hazard. Repair or replace them immediately to prevent short circuits and blown fuses. If cord is frayed, throw it away. *Except:* if frayed or damaged only at one end, it may be repairable (see at right). Sometimes a cord that looks good won't work . . perhaps a broken wire (see page 33). Or the prongs may be bent. Or wires may have become disconnected from the terminal screws.

Whenever a cord is damaged or broken close to either end, just cut wires and outer cover as shown. Disconnect plug from damaged piece of cord, and connect terminals to the long piece.

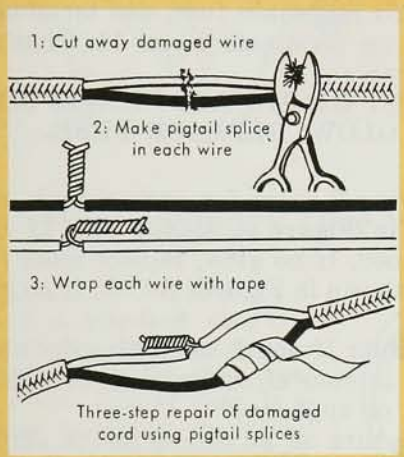
Round attachment plugs usually provide enough space to allow use of Underwriters' knot to help secure wires. See page 33.

How to replace switches, repair cords

Replacing old push-button type or toggle switch

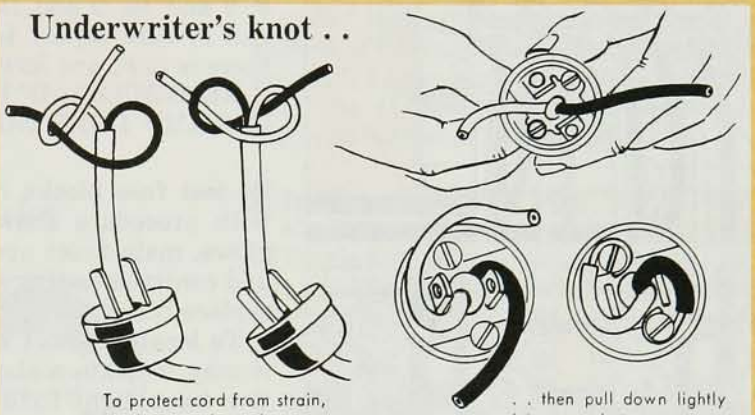


Remove 2 screws to disconnect switch plate: then remove 2 screws holding switch to box. Install new switch, using same wire hook-up as before



Three-step repair of damaged cord using pigtail splices

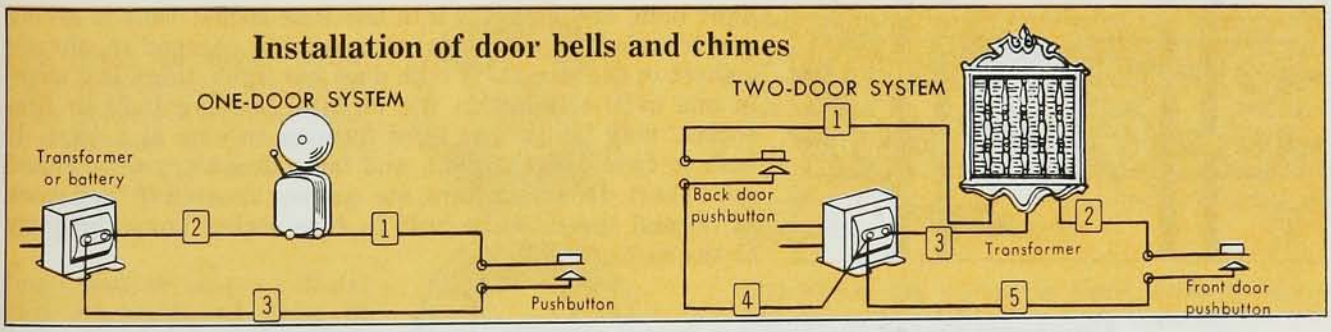
Underwriter's knot . .



To protect cord from strain, just loop cords as shown . .

. . then pull down lightly into recess between prongs

Installation of door bells and chimes



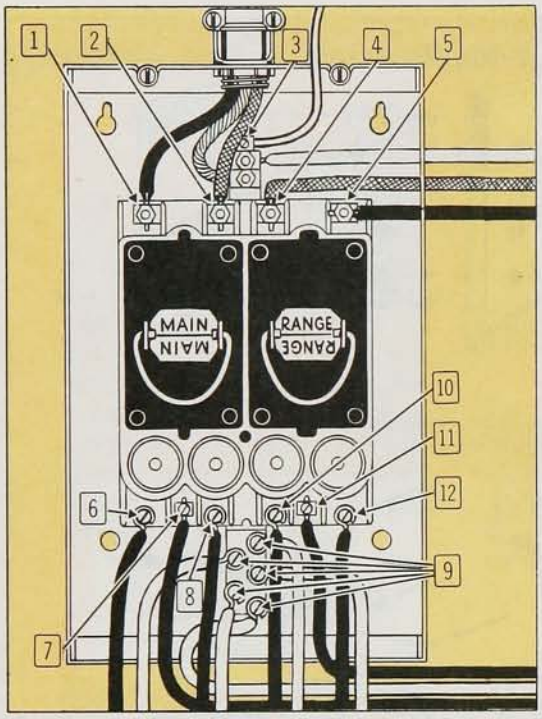
Buzzers and doorbells require low voltage through a transformer or dry cell battery hook-up. The transformer reduces 120-v current to voltage desired. 1½-volt batteries, hooked in series, also provide needed voltage. Heavy insulation is not needed. Run bell wire behind baseboards, under molding or floorboards. Use from low voltage side of transformer.

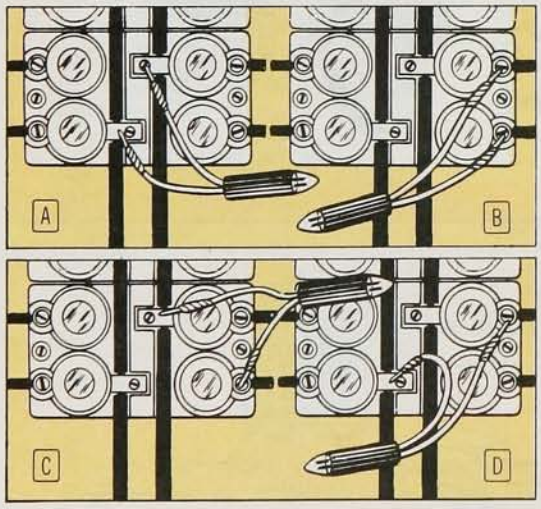
If batteries are used, connect in series. Four 1½-v batteries in series, produce 6 volts. One-door system, shown above, is the simplest type installation. Wire (1) is run from bell terminal to pushbutton. Wire (2) runs to low-voltage side of the transformer (or to batteries). Wire (3) runs from pushbutton to transformer.

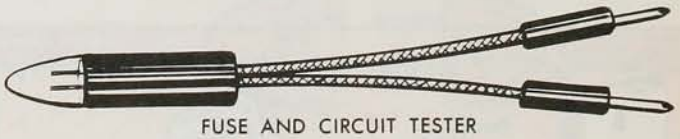
Two-door chime system: front door and back door chime hookup is a little more complex. Connect wires (1) and (2) from combination chime terminals to pushbuttons. Connect wire (3) to low voltage side of transformer. Next, hook up wires (4) and (5) from terminal to each pushbutton.

Door chimes—mellow and pleasing. Most chimes call for 16 volts, and, for best service, a special chime transformer.

Testing Devices locate trouble quickly







FUSE AND CIRCUIT TESTER

It's simple to locate blown fuses with this little tester. On a panel similar to the one at left, here's the trick. Hold the insulated tips of the tester, and touch terminal 1 with one tip, terminal 3 with the other. If lamp glows, everything's fine. Then repeat the procedure on terminals 2 and 3. To test the range fuse, use terminals 3 and 4. Repeat on 3 and 5. Remember: lamp will glow if fuses are OK.

To test lighting and appliance circuits. Touch tester tips to terminals 6 and 9. Repeat on terminals marked 8 and 9, 9 and 10, 9 and 12. To test main fuse, use terminals 7 and 9, then repeat test on terminals 9 and 11. That's all there is to it, and how simple it is.

REMEMBER: IF LAMP **GLOWS** THE FUSE IS **GOOD.** IF LAMP DOES **NOT** GLOW, **REPLACE FUSE.**

To test fuse blocks having 2 fuses for each circuit, start with procedure shown in Figure A to the left. If light glows, main fuses are good. If no glow, replace main fuse, and continue testing as shown in Figures B-C-D. If no glow, replace fuse.

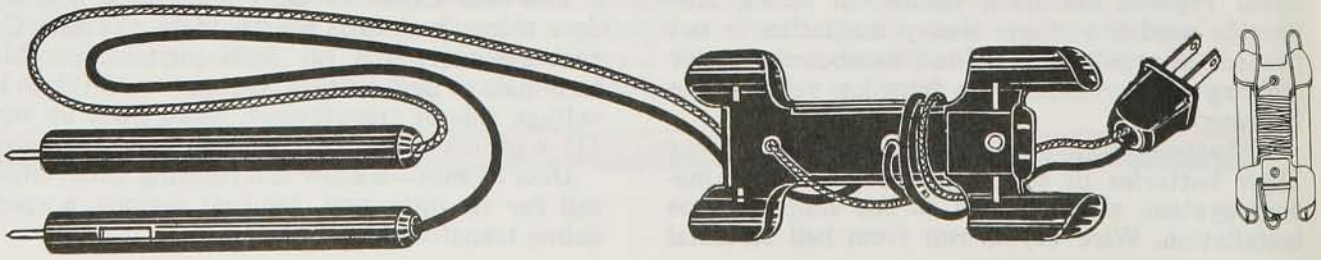
To locate a short circuit: If one fuse continually blows, it may indicate a short in your circuit wiring, or a defective lamp, light fixture, or appliance.

To discover the cause, turn off all ceiling lights, shut off all wall switches, and disconnect all cords, lamps and appliances on the circuit you suspect. Then take a 100-watt light bulb, and screw it into the fuse socket that is giving you trouble. If bulb lights with nothing plugged in, there's a short in the circuit. If bulb does **not** light, there is a short in one of the items on the circuit. Leaving bulb in fuse socket, plug lamps and light fixtures in, one at a time. If bulb in fuse socket lights, and lamp doesn't, you've found your short. Irons, toasters, etc. are not shorted if they work at normal speed, while bulb in fuse socket burns brightly at the same time.

Universal tester for testing fuses, circuits, cords, appliances

This little device belongs wherever electricity performs. It locates current leakage in appliances and motors, finds defective cords, locates shorts.

It will perform all the tests mentioned above and more. The Universal Continuity and Line Tester card has helpful suggestions shown on the package.



What to do if fuses blow or circuit breakers trip frequently

section 7

How ordinary fuse works

This is a standard plug-type fuse. The current passes through the metal strip running across face of fuse. It is designed to protect the circuit against shorts and overloading.

Fuse blown by short circuit. Metal strip is instantly heated to an extremely high temperature, causing it to vaporize. Fuse window discolors.

Fuse blown by overload. Metal strip overheats and melts at the weakest point, breaking flow of current to circuit. Fuse window remains clear.

Circuit breaker switch. When overloads or shorts occur, it will switch off automatically. Reset it immediately after correcting trouble.

Fuses and Breakers are safety valves

A blown fuse or a tripped circuit breaker is a signal that something has gone wrong with your electrical system and should not be ignored. If it happens frequently, it could run up your electric bill, cause appliances to give poor service, or set fire to your house.

There are four types of circuit failure. The following will tell you how to identify and correct each type.

Why do circuits fail?

1 **Loose connection.** A screw may be loose in the socket into which the fuse is inserted. If the *bottom* of the fuse is severely discolored or pitted, you have a loose connection. After making certain that the main switch is disconnected, tighten screw in bottom of fuse socket.

2 **Improperly seated fuse.** If the fuse window shows no evidence of a blown fuse or if bottom of fuse is not pitted or discolored, the fuse is either not seated properly or is not long enough to make contact. Replace with another fuse that will make contact.

3 **Short circuit.** If the window of the blown fuse is discolored, you have a short circuit. This means that somewhere on this circuit, a bare wire is touching another bare wire or other metal. In circuits protected by circuit breakers or by cartridge-type fuses, there is no visible clue as to what might be at fault but the procedure to follow is the same.

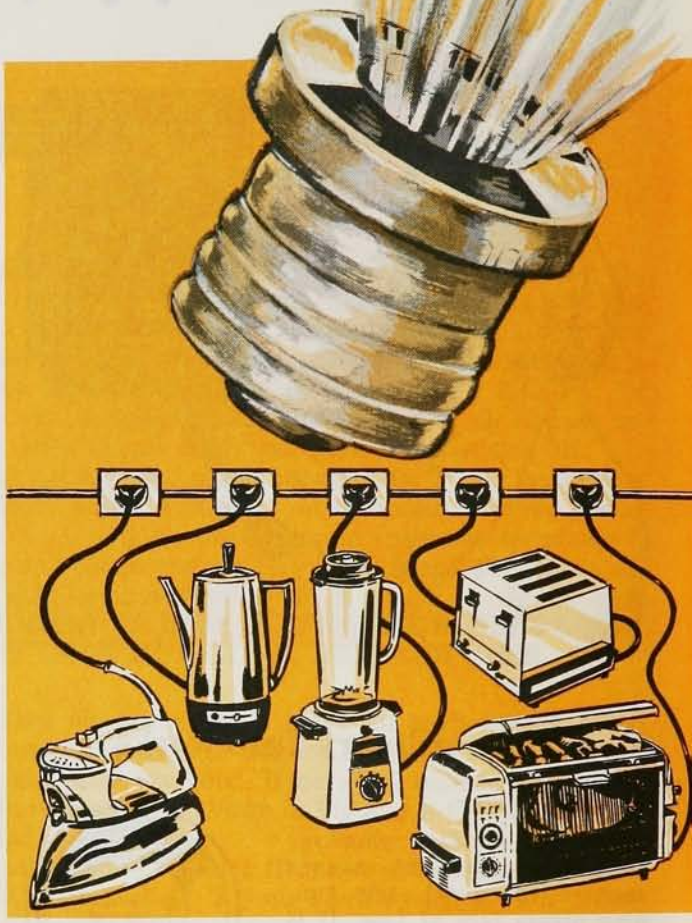
(A) Unplug all lights and appliances served by the blown circuit—in other words, all lights and appliances that don't work.

(B) When the circuit is clear, replace fuse or flip the circuit breaker switch back on.

(C) Turn each lamp or appliance on one at a time. When you reach the faulty lamp or appliance, the new fuse will blow or circuit breaker will trip. Examine the lamp or appliance and you will probably find the bare wire in a frayed cord or in the wiring of the appliance. Repair it and your problem should be solved.

(D) If the new fuse blows or the circuit breaker trips when the circuit is completely clear, there is a short in the wiring of the circuit itself, and the wiring will have to be repaired or replaced.

More about fuse and circuit breaker problems



4 Overloaded circuit. If the window of the blown fuse is clear, you have an overloaded circuit. This is the most common cause of circuit failure. In circuits protected by breakers or cartridge-type fuses, there is no visible clue but the procedure to follow is the same. There are two types of overloads—

(1) Temporary overload. The typical temporary overload exists when a motor kicks on because, during starting, an electric motor will draw about three times its normal current. You can remedy this by using a time-delay fuse of the correct size (either 15 or 20 amp.). Its purpose is to absorb temporary overloads without blowing. If it does not blow with everything on the circuit turned on, then you had a temporary overload and the problem has been corrected. In circuit breaker systems, the breakers will absorb temporary overloads without tripping.

(2) Constant overload. If you determine from your tests that the overload is not temporary and continue to experience circuit failure, you can either shift some appliances from the overloaded circuit to another circuit or add a new circuit or circuits to your system.

It is advisable at this point to make a survey of all circuits so that you know how big a wattage load each is carrying. This can be done by making a chart like that shown on page 37. Number each fuse or circuit breaker number 1, number 2 etc., then follow this procedure:

(a) Turn on all of your lights and be sure all bulbs are burning. Remove fuse number 1 and go through the house marking a #1 on the chart for every light that's out. Do the same for all wall outlets, using a night light to make sure which receptacle outlets are on the circuit being tested.

(b) Make a list of the wattages of everything served by this circuit and list them in the column for the number 1 fuse. The wattage of an appliance is usually shown on the name plate or underside. If amperes is shown instead of wattage, multiply amperes by 120 to convert to wattage (example: .75 amp. × 120 volts = 90 watts). If only a horsepower figure is given, multiply horsepower by 746 (1 horsepower equals 746 watts). If no rating can be found, use the figures shown on pages 6 and 7 of this booklet.

(c) Repeat steps (a) and (b) for each circuit. Don't overlook closets or tools and appliances that are not permanently on such as fans, furnace motors, sump pumps, air conditioners, etc.

(d) Add up the wattages of the lights and appliances on each circuit and figure the various appliances that might be plugged in at one time. If, for example, you find you have a circuit with a 15-amp. fuse and 14-gauge wire with an estimated load of over 1650 watts, you have an overloaded circuit. A circuit using a 20-amp. fuse and 12-gauge wire should not carry more than 2200 watts. If you don't know what size wire you have, see page 39.

Testing devices help you to locate circuit troubles faster. See page 34

See following page for aid in making an inventory of your wiring system and correcting constant overloads

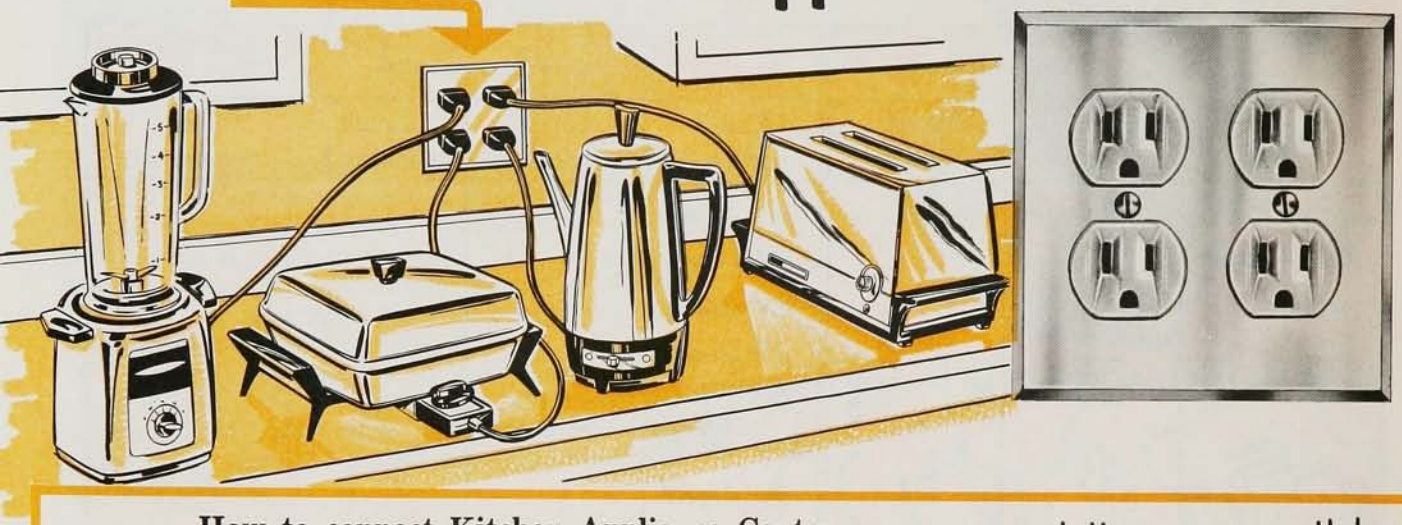
Example of a circuit survey showing an overloaded circuit

Location	Circuit Numbers		Wattage Load			
	Ceiling Outlet	Wall Outlets	Circuit number 1	Circuit number 2	Circuit number 3	Circuit number 4
Living Room	#1	4 #1	150 Lamp			
Porch and			150 Lamp			
Hall			150 Lamp			
			75 Lamp			
			300 TV			
			300 Stereo Hi-Fi			
Dining Room	#1	3 #1	150 Light			
			40 Light			
			40 Light			
Kitchen	#1	4 #1	60 Light			
			300 Refrig.			
			150 Radio			
			1000 Toaster			
Bathroom	#2	2 #2	1000 Iron	60 Light		
Bedroom 1	#2	3 #2	1450 Rotiss.	40 Light		
Bedroom 2	#2	2 #2	130 Mixer	40 Light		
Bedroom 3	#2	2 #2	600 Perk.	20 Shaver		
			100 Fan	60 Light		
				75 Light		
				40 Light		
Garage	#3			150 Radio	200 Lights	
Basement	#3	3 #3		4 Clock	100 Lights	5200 Washer-Dryer
				60 Light	400 Furnace	(220 amp. circuit)
				75 Light		
				75 Record Player		

A circuit survey of your wiring system will help you check for overloads. In the above, it is obvious that circuit number 1 can cause trouble since it wouldn't take many appliances plugged in simultaneously to pull more than the 1650-watt limit of circuit (15-amp. fuse, 14-gauge wire).

Solution. Split the old circuit into two or more circuits and separate living room, hall and porch circuit from the kitchen and dining room; or run a new circuit or circuits into the kitchen to a four-outlet appliance center—this is the solution we recommend (see next page).

The answer to most overloading.. install a 4-outlet kitchen appliance center



How to connect Kitchen Appliance Center to the Service Entrance Panel

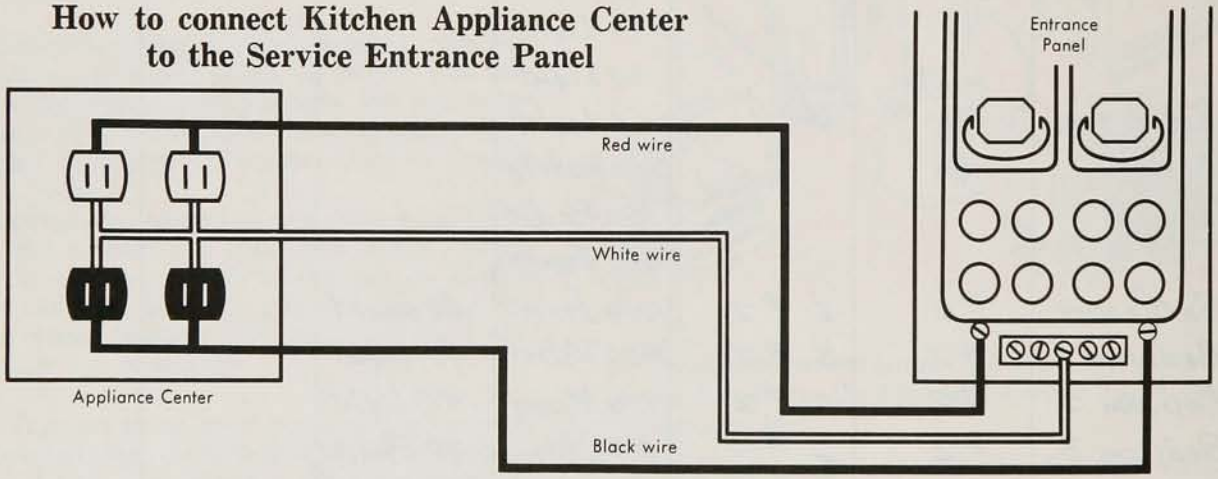
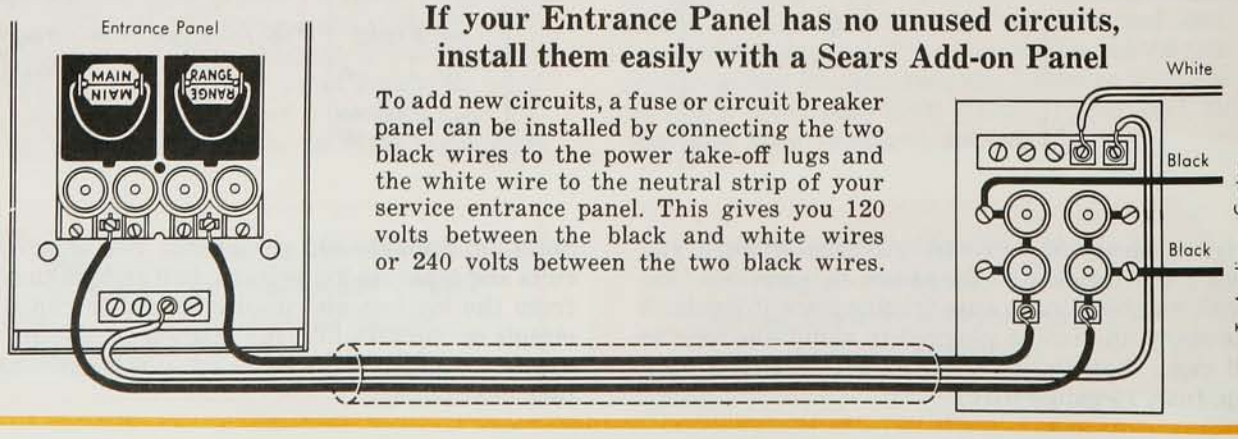


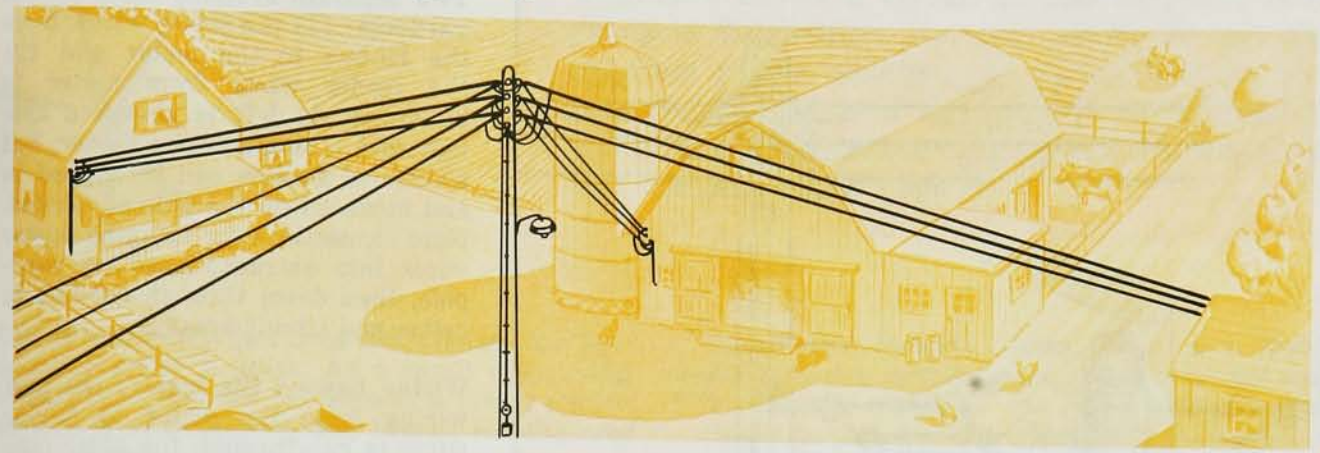
Diagram above shows 120-240-volt circuit connecting appliance center to two spare fuses in entrance panel. Permits using four appliances at once up to 4600-watt capacity. Takes 2-prong standard or 3-prong grounded plugs. From two circuits and neutral in service entrance panel, run no. 12 3-wire cable as shown above. This gives two circuits in one box.

If your Entrance Panel has no unused circuits, install them easily with a Sears Add-on Panel

To add new circuits, a fuse or circuit breaker panel can be installed by connecting the two black wires to the power take-off lugs and the white wire to the neutral strip of your service entrance panel. This gives you 120 volts between the black and white wires or 240 volts between the two black wires.



Yardpole outdoor wiring system recommended for farms and ranches



The yardpole is the central distribution panel for feeder wires to all buildings. Your local power company will help you choose the best location, and will frequently set up the pole and install all wiring into the meter (usually mounted on pole).

Change-over existing service entrance? Often the service entrance equipment serving the entire farm originally ran into the house. Feeder lines went to the barn and other outbuildings. This is why the last building served usually had very low voltage—result of the distance from the meter. A yardpole and load-distribution center can correct this. It assures that no building is too far from the main service. Or—you may already have a yardpole, but with too small a service entrance. If so, check your power company.

Best idea — a separate 3-wire feeder to every major building. Start with correct size service entrance wires (see pages 8-9) for a minimum of 100-amp, 150-amp or 200-amp switch on the yardpole. Then run 3 wires to a 60 or 100-amp subpanel in the house, 3 wires to a 60-amp subpanel in the barn, and 3 wires to a 30-amp subpanel in your machine shop or shed. Or you may be able to wire one small building from another if you plan on using only lights or very small appliances. See page 42 for more information.

Wires **must** be heavy enough to withstand ice, wind and weather—and to satisfy the Code, which specifies nothing smaller than No. 10 wire up to 50 feet, nothing smaller than No. 8 over 50 feet.

To find the right size wire to each building, you must know (1) distance from yardpole to building and (2) approximate amperage to be used there at one time (to find amperage, divide wattage by voltage). Select feeder sizes from top table at right, entrance and interior sizes from lower table.

Adequate Wire Sizes . . Weatherproof Copper Wire

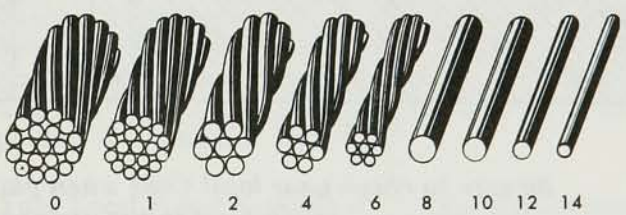
Load in Building Amperes	*Distance in Feet from Pole to Building*	**Recommended Size of Feeder Wire for job*
Up to 25 amperes, 120 volts	Up to 50 feet	No. 10
	50 to 80 feet	No. 8
	80 to 125 feet	No. 6
20 to 30 amperes, 240 volts	Up to 80 feet	No. 10
	80 to 125 feet	No. 8
	125 to 200 feet	No. 6
	200 to 350 feet	No. 4
30 to 50 amperes, 240 volts	Up to 80 feet	No. 8
	80 to 125 feet	No. 6
	125 to 200 feet	No. 4
	200 to 300 feet	No. 2
	300 to 400 feet	No. 1

*These sizes are recommended to reduce "voltage drop" to a minimum

Ampacities of Copper Wires

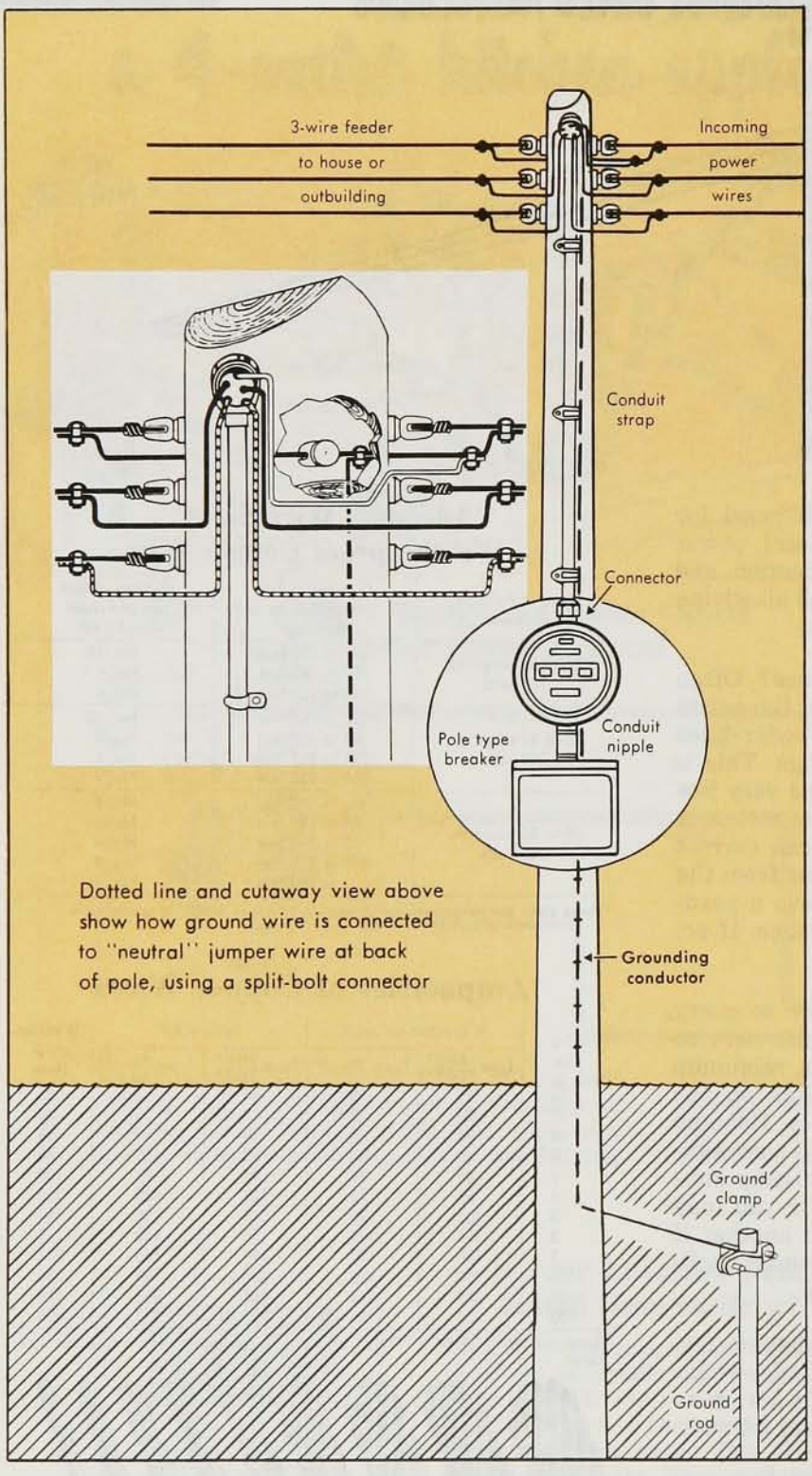
Wire size	*In Conduit or Cable*		*In Free Air*		*Weather-proof Wire*
	Type RHW* THW*	*Type TW, R**	*Type* RHW* THW*	*Type TW, R**	
14	15	15	20	20	30
12	20	20	25	25	40
10	30	30	40	40	55
8	45	40	65	55	70
6	65	55	95	80	100
4	85	70	125	105	130
3	100	80	145	120	150
2	115	95	170	140	175
1	130	110	195	165	205
0	150	125	230	195	235
00	175	145	265	225	275
000	200	165	310	260	320

*Types "RHW," "THW," "TW," or "R" are identified by markings on outer cover



Actual size of copper conductors. Note the larger the gauge number the smaller the diameter of the wire.

Wiring the yardpole



Two separate systems meet at the yardpole: (1) the power wires, from the Hi-line to the meter and (2) the feeder wires from meter to buildings. At left is shown a system with a single 3-wire feeder, but additional feeders can be tapped in and mounted on the pole as needed. Note connections for bringing power wires into entrance head on yardpole, then down through conduit to meter and circuit breaker.

Wiring beyond the meter: see how wiring from the meter to feeder wires is run through the same conduit as incoming power wires and out the same entrance head. EXCEPTION! Some localities do not permit unmetered and metered wires to run in the same conduit. Check your local power company for ruling.

Mounting feeder wires: feeders to your various buildings must run so that they touch nothing except insulating supports: and must be at least 10 feet away from trees, roofs or other obstructions.

Grounding at yardpole: grounded wire is shown at left as a dotted line. It should be connected at top of pole to overhead "neutral" wire, then run to the ground on the pole side opposite the meter. Grounding conductor should be copper—no smaller than No. 6—and must be fastened every 6 inches through the length of its run. Run wire in conduit or armored cover in cases where it might be subject to mechanical injury.

Ground rod: should be non-ferrous type, not less than ½-inch diameter and 8 feet long. Locate at least 2 feet away from yardpole, and drive rod top at least a foot below soil.

Note: Use above grounding where underground metallic waterpipe systems are **NOT** available. See page 14.

Be sure to check your local Code when planning your wiring. Also be sure that materials you intend to use are approved by your Power Company

Wiring Farmsteads

This view shows a typical farmstead set-up with yardpole distribution. However, many farmers and ranchers prefer underground wiring because it is almost entirely out of sight and is not affected by ice, wind and bad weather. For underground installation instructions see page 46.

Use of electricity on farms and ranches has been doubling every 8 years. As a result many older installations are now inadequate. A larger electric service is often needed, and branch circuits need the capacity to deliver full power to outlets.

The relative cost of an up-to-date farm wiring system to total farm investment is small, yet the return can be substantial in dollars as well as in work-saving convenience. Whatever your electric needs are now, those needs will probably increase in the future. **Gear your system to growth . . no farm is ever "overwired".**

150 to 200-ampere service for a farm is now common . . 100-ampere service is the minimum.

PLAN . .

1. Enough branch circuits to all buildings to avoid long extension cords . . enough circuits to prevent overloading with resulting poor voltage and danger to motors and other electrical equipment.

2. Special-purpose 240-volt outlets for motor-driven equipment of ½-HP and over.

3. Enough duplex outlets, conveniently located for smaller plug-in appliances and equipment.

4. Plenty of switch controlled lights to reduce eyestrain and to prevent accidents.

5. Enough switches to control lighting of stairs, silos, mow ladders (from above and below). Have a switch at latch side of each door to light way.

6. Separate grounding of all permanently installed motors and other electrical equipment.

Size of Circuit Wires

20-amp. branch circuits with No. 12 wire are recommended as minimum. Larger size wire costs little more than smaller size. With heavier wire you get better service and can add more equipment without overloading. In general, size of wire is determined by length of run and the electrical load to be carried and the maximum voltage drop permitted at the point of service.

Distribution System, shown above, is a typical pole metering installation with the meter and main disconnect located on the same pole. The pole should be placed at a point as close as is practical to the electric load center of the farmstead. This is called "load center distribution". Feeder lines radiate from pole to house, barn and other structures. Design the lines to hold *voltage drops* to a minimum, especially those that feed circuits servicing brooders, heaters in farrowing or lambing pens, incubators or any equipment in which life processes are at stake.

Installation Suggestions. With either overhead or underground wiring the meter is generally located on a pole, but sometimes on the outside or inside of a building. Note that in overhead wiring that no wires pass over or through any of the buildings. This is recommended for delivery of uninterrupted power and to minimize the possibility of service being cut off by fire in any of the buildings.

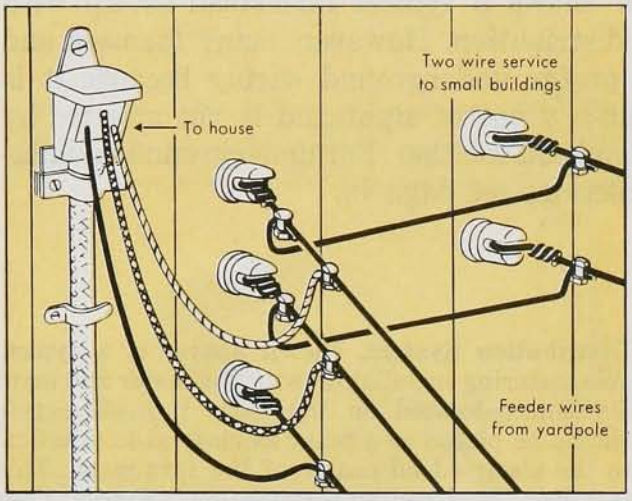
Outside Lighting. Individual outdoor floodlights located strategically are one of the better ideas. It is great to be able to light your way to the job while on the job. See page 45.

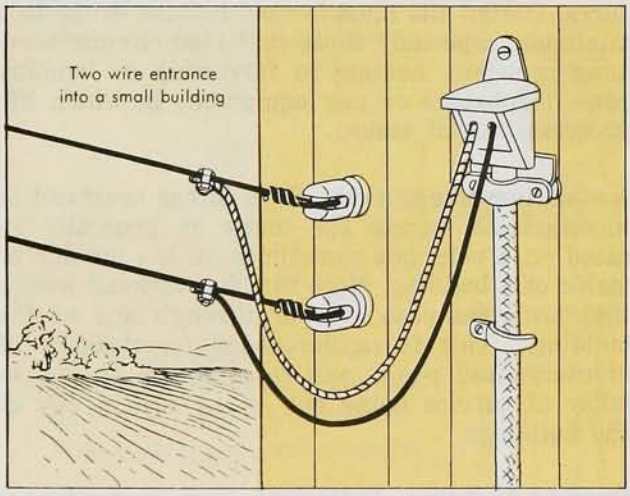
Water where and when you want it

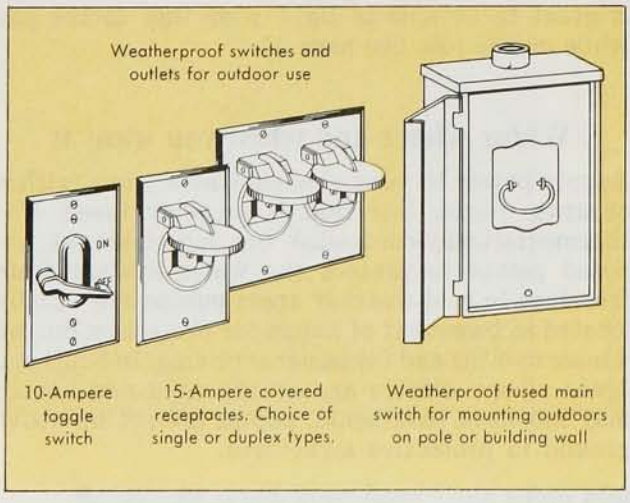
Supply power to your electric water pump with a separate feeder line that is properly fused. Use thermostatically-controlled heating cable at exposed points to protect the water system from freezing. In cold weather areas pumps are usually located in basement of house for protection during winter months and for easier servicing. In Southern areas where winters are usually mild and houses may not have basements, pumps are set up above ground in protective structures.

Your Local Power Supplier will gladly discuss your present and future wiring requirements and will suggest types of wiring, equipment and materials. Also see Sears.

2-wire service to outbuildings







When running wires to outbuildings be sure that wires are heavy enough to carry the electrical load and that the wiring is fastened securely to a strong, well-supported building.

To tap 2-wire from 3-wire service

Method shown at left is used only for systems wired from a yardpole. (See page 45 for 2-wire electric service for systems without yardpole.)

Two-wire service should be planned only to outbuildings requiring a load of less than 3500 watts and using motors of ½ HP or less. The 2-wire lines may run direct from yardpole but usually it is easier to tap off wires running from yardpole to a neighboring building, provided those wires are heavy enough to carry the increased load. This method makes it unnecessary to wire through entrance panel of neighboring building. You usually ground this system at each building.

2-wire Electric Service

Regular weather-proof wire is used . . 8-gauge is recommended to withstand ice and wind. Insulators on buildings should be placed so that wires are at least 12 in. apart. Wires must clear ground by at least 18 ft. over driveways and 10 ft. over foot walks. Use either conduit or service entrance cable on the vertical run. Method of installing a 2-wire electric service is essentially the same as outlined on pages 12 and 13 except that 2-wire cable and a smaller service panel will be used. A 30-ampere, 120-volt service panel is usually used, protected with fuses no larger than capacity of smallest wire.

Outdoor Switches and Receptacles

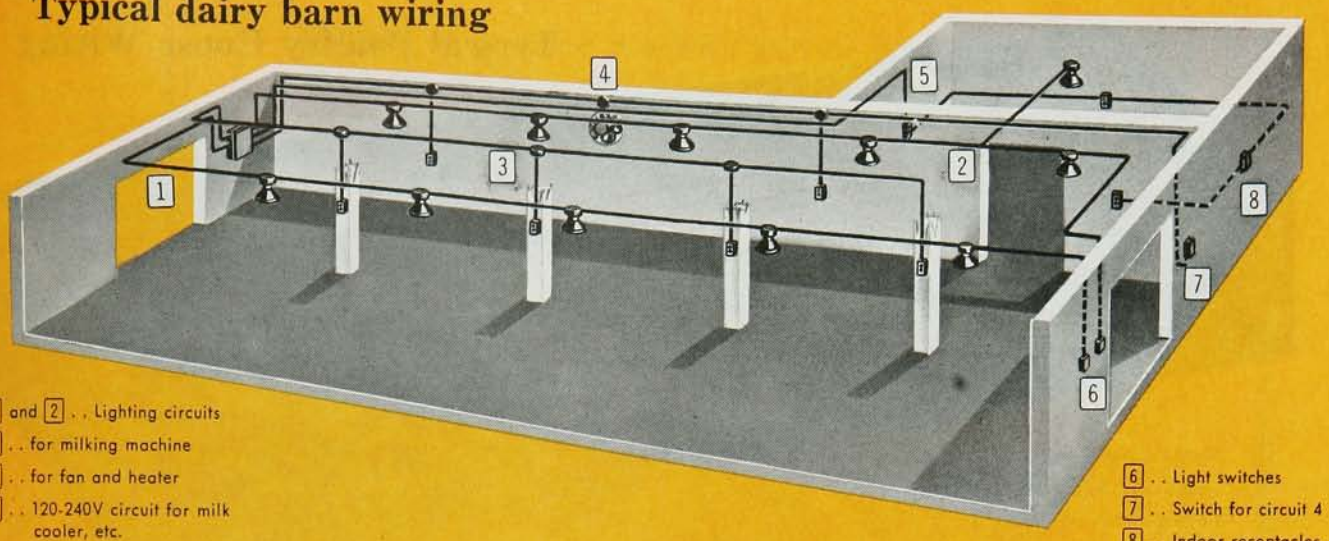
To use electrical equipment in damp locations and outdoors, weather-proof devices must be installed where motors and high-wattage farm equipment can be conveniently plugged in.

Outdoor switches and receptacles vary in size. A 15-amp. receptacle is large enough for most jobs but if a larger motor (½-HP or over) is to be used, heavier switches and receptacles are needed and they must be installed on a 3-wire 240-volt circuit. When wiring receptacles, connect black or red wires to brass colored terminals; white wires to light-colored terminals. For underground wires see page 46 for rules.

Be sure to check your Local Electrical Code for special regulations, if any, for your locality

Wiring recommendations for dairy barn and other farm buildings

Typical dairy barn wiring



1 and 2 . . Lighting circuits
3 . . for milking machine
4 . . for fan and heater
5 . . 120-240V circuit for milk cooler, etc.
6 . . Light switches
7 . . Switch for circuit 4
8 . . Indoor receptacles

Electric Automation comes to the farm

Bulk milk cooling, food grinding and mixing, a host of other chores that used to require hours of hand labor are now taken over by electrical helpers. However, these servants can only be at their best and most efficient with proper wiring.

Barn and outbuilding wiring is essentially the same as house wiring, and requires the same careful attention. Run cable along sides, rather than the bottom of beams and joists. Run crosswise cable through drilled holes rather than over surfaces, (or protect it by running boards). Attach cable to interior studs and posts when possible, where it is protected from the weather.

To determine the number of branch circuits, figure each outlet at 1.5 amps, or 175 watts.

More efficient dairy barns

Plan on one light outlet for every 2 or 3 stalls on center line of alley, wall-switch controlled for litter-alley. Install 1 outlet every 10 or 15 feet on center line of feed-alley, separately switch-controlled from litter-alley outlets. You should probably plan on special-purpose outlet for ventilating fans.

Loose housing barns, box stalls and pens require one light outlet for every 150 square feet of open pen area, 1 ceiling outlet for each bull maternity or calf pen—wall-switch controlled. Good idea—convenience outlets every 20 feet for clippers, portable milkers and such. (Place outlets and lights high enough to be out of animal's reach.)

In milking room or parlor, install 1 light outlet in front of every 3 cows, 1 outlet behind every two cows, all wall-switch controlled, 1 convenience outlet for every 4 to 5 cows.

Milkhouse: 1 light for every 100 square feet is suggested for general lighting plus a convenience outlet for each work area for plug-in type water heaters (250 to 1000 watts) and motor-driven devices of less than ⅓ Hp. Special-purpose outlets may also be needed for **can-type milk cooler** (120-240V), **bulk type cooler** (240V), **utensil sterilizer** (120-240V), **fan** (120V), **heating equipment** (120-240V), or **water heater** (120-240V).

Another good idea: Place outlets high enough to avoid splashing. They'll work better.

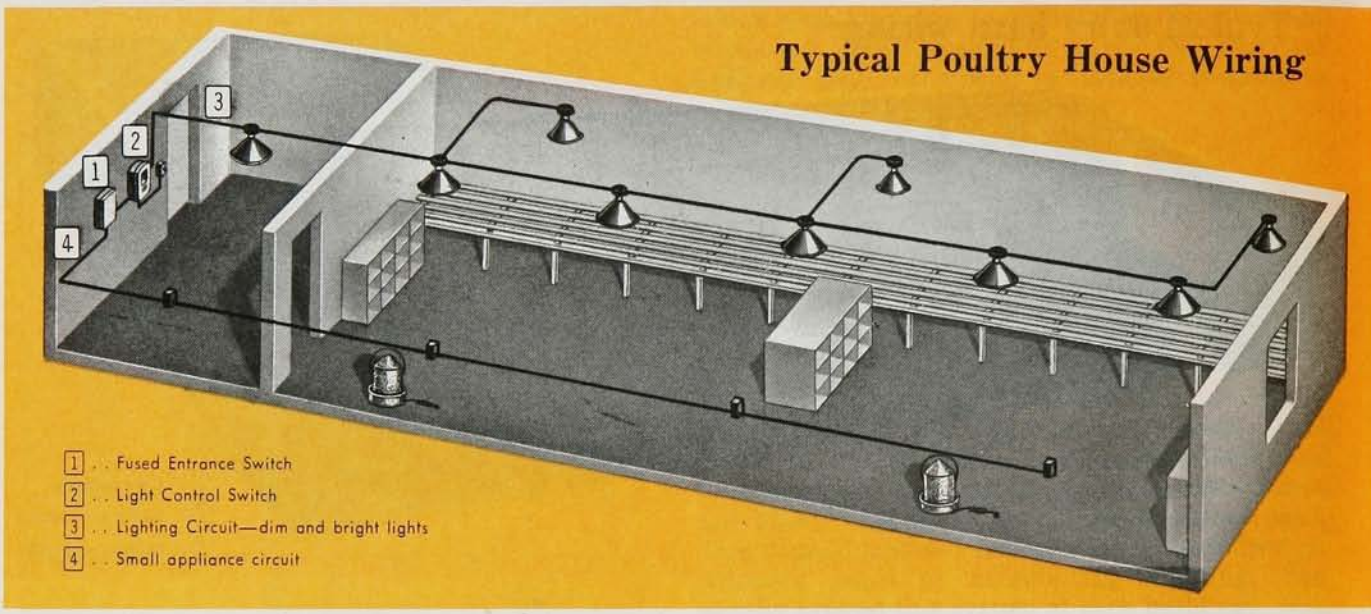
Beef cattle barns, sheep barns and hog farrowing houses

A wall-switch controlled light outlet for each 150 square feet of open pen area is just right for a beef cattle barn. Where a feed alley is used, whether beef cattle or sheep barn, plan on a light outlet every 15 feet. For hog and farrowing houses, 1 wall-switch controlled light outlet is ample for each pair of hog pens. Locate over partition lines. In low houses, mount double row of ceiling lights, one for each pair of pens. In cattle barns, plan on 1 outlet at each location where equipment can be used handily. For farrowing pens in sheep barns and hog houses provide convenience outlets for brooders and water warmers.

Suggestion: use 3-wire 120-240-volt circuits for heat lamps, with alternate outlets connected to opposite sides of circuit to balance load better. **In all barns,** add a special-service outlet for heating cable or device to keep water supply from freezing.

Wiring for barn and farm buildings

Typical Poultry House Wiring



1 . . Fused Entrance Switch
2 . . Light Control Switch
3 . . Lighting Circuit—dim and bright lights
4 . . Small appliance circuit

Poultry Laying House (see above). Be sure to install both dim and bright light circuits for more production. Here are some recommendations:

Morning Lighting: Use one outlet for every 200 square feet of floor area (if house or pen is 20 feet deep, place at least one row of outlets 10 feet apart midway between front of house and dropping board). Install time-switch control for outlets.

Morning and Evening Lighting: Install bright lights as above; install dim lights on separate circuit. Put in one outlet for every 400 square feet of floor space. Line them up slightly in back of bright lights—10 watts each—and install time-switch control.

All-night Lighting: One 10 or 15-watt unit for each 20 square feet (have two to prevent interruption should one burn out). Place over feed and water areas, with switch control for each pen.

Outlets are required for motor-driven feeders and convenience where cold weather demands that poultry drinking water be warmed. Install one outlet each 400 feet of floor area, one outlet for each pen at least 3 feet high. To lessen dust collecting on contacts hang from ceiling on pendant cord connectors, using number 12 wire and cords of SJT, ST, SO or SJO type. You may need special outlets for elevators, hoists, conveyors and fans.

Brooder House: Install one outlet for each pen or house plus special-purpose outlets on ceiling for each 1000 watts of hover-type or four-lamp infrared type brooder. Use 3-wire, split-circuit 120/240-volt wiring where a number of units are operated (see page 26). Battery brooders, incubators, egg storage and handling rooms, poultry cleaning and dressing rooms need one outlet for each 200 feet of floor space. Install convenience outlets, special outlets and circuits as required.

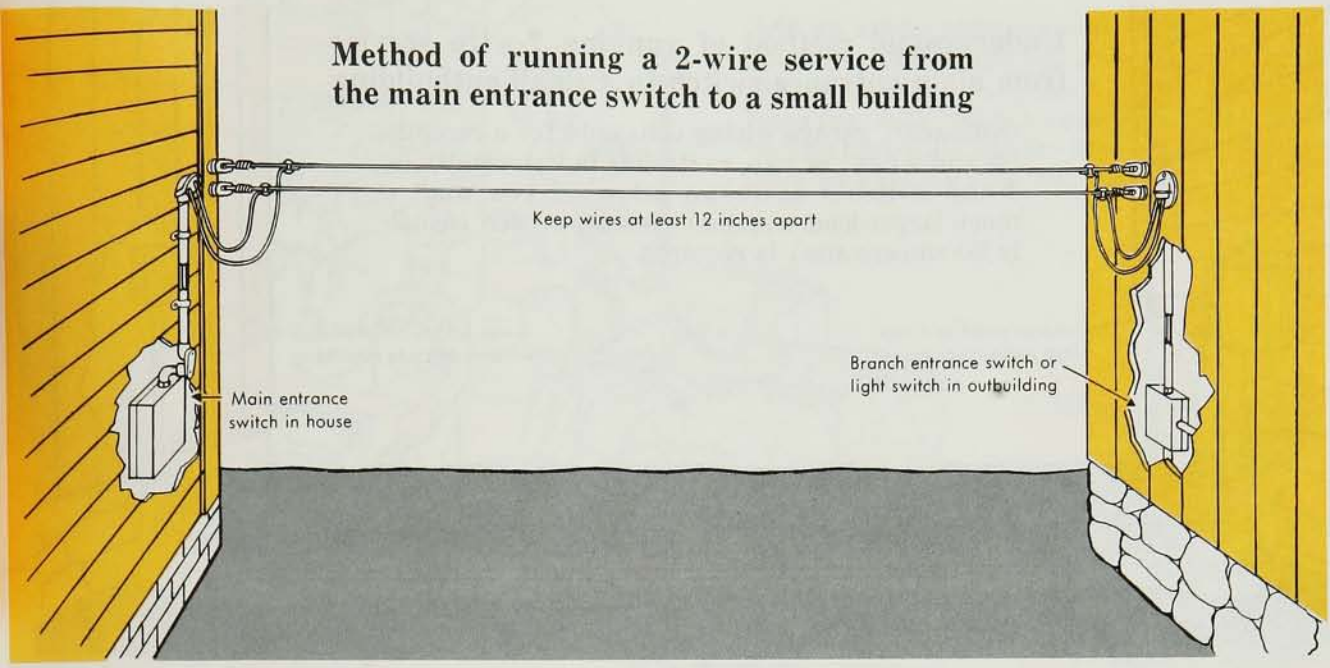
Recommendations for Farm Shop

One outlet for every 200 square feet is ample for general lighting. Also allow one outlet for each permanently set piece of equipment, such as a saw, or grinder. Plan on at least one outlet for each 10 feet of bench space, wall switch controlled. Install one convenience outlet for each 5 feet of bench space: and one outlet for each permanently placed item less than ⅓ HP, such as drills and forges. Motors ½ HP and over should have a special-purpose 240-volt outlet. There are now "farm" welders, whose electrical characteristics are especially suited for use on rural lines. They have a rated input up to 37½ Amps at 240 volts. Generally a 50-amp, 3-wire outlet is used. (Some power suppliers have regulations concerning use of welders. Check with them).

Safety Note: See page 14 for general instructions covering grounding . . especially important in such damp locations as dairy barns and poultry houses. Prevent accidents! Be sure all equipment **and** your wiring system are correctly grounded.

Local Farm Advisors of the Power Companies together with your State College Extension service should be consulted on planning and Local Regulations.

Overhead wiring



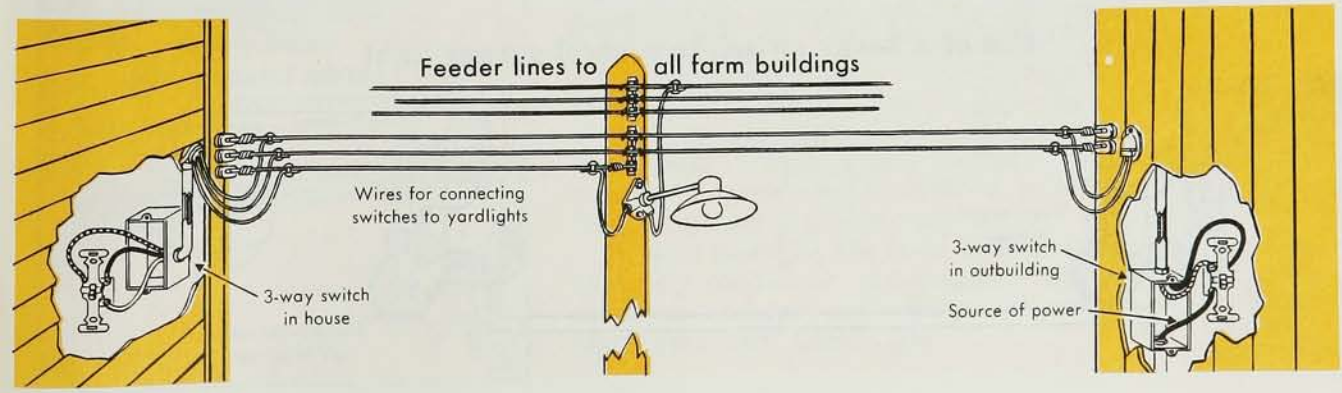
Generally a garage or out-building requires a small electrical load. Wiring method above is for building to building. DO NOT USE with systems wired from a yard pole! (See page 40 for yard pole systems.) Another warning: since overhead wiring is exposed to wind and ice, durable installation is a **must.**

Installation: when main entrance switch is inside house, come through wall and up side of building to entrance head with 2-wire number-8 entrance cable. (Use number-10 weatherproof wire for runs *under* 50 feet.) When entering a building (see above, right) and wires go down inside building, use a flange-type entrance head with conduit, armored or sheathed cable. The same type head can be used in installation above left. You simply run up the inside of the building with conduit, armored or sheathed cable. Loops from overhead wires are made from entrance heads to insulated brackets (at least 15 feet above ground).

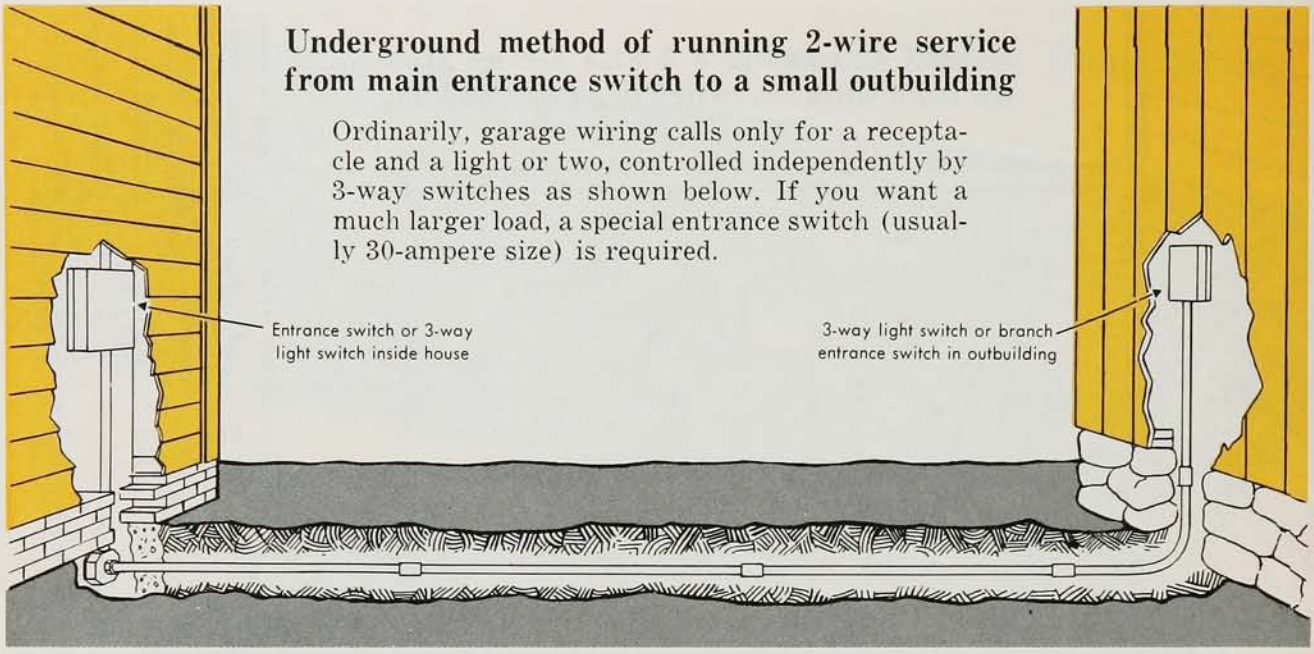
DETERMINE WIRING within the building by the amount of electricity required. A toggle switch does for a few lights and receptacles. But an entrance switch must be installed for branch circuits.

TO MOUNT A YARDLIGHT on a yardpole: if barn is already wired, simply use installation shown below. Control yardlight from both house and barn with 3-way switches. Notes that in hookup below, there are 3 wires from house to light, only 2 from light to barn. You save a length of wire because you tap the "neutral" off feeder wire on yardpole.

View below shows common method of mounting Yardlight on a Yardpole



Underground wiring



Underground method of running 2-wire service from main entrance switch to a small outbuilding

Ordinarily, garage wiring calls only for a receptacle and a light or two, controlled independently by 3-way switches as shown below. If you want a much larger load, a special entrance switch (usually 30-ampere size) is required.

Underground wiring is particularly useful when overhead wiring to outdoor outlets would be unsightly, or in the way, as in garages or barns.

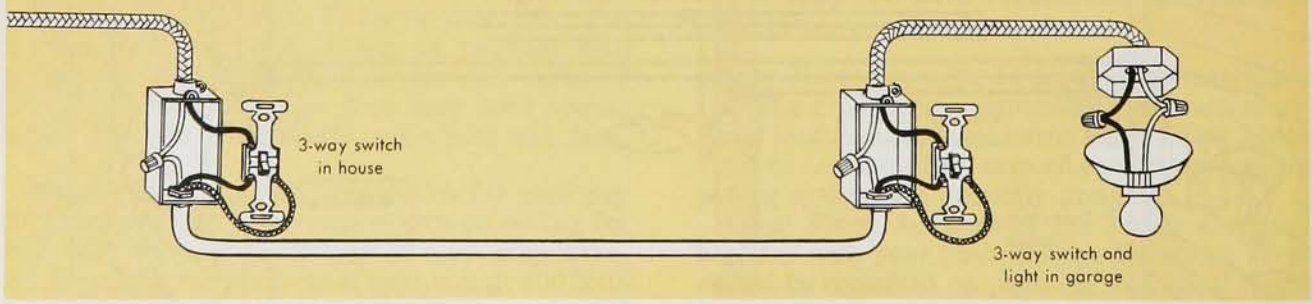
There are two types of underground wiring: (1) trench cable, (2) dual-purpose plastic cable (see p. 16). Single-wire trench cable is generally used for larger-size underground services. Enclose wires in conduit wherever they are subject to mechanical injury, such as under heavily-used driveways. And, if possible, bury conduit or other type wiring, 18 to 24 inches below frostline. This prevents heaving and condensation.

Check your Local Code for types of underground wiring approved in your area. This is important!

INSTALLATION IS MADE as shown above. Tap wires off a junction box or entrance switch in the house, run wires down and through the basement wall. Be sure to seal wall when conduit runs into building for protection against water seepage. This conduit is then run through the wall of the outbuilding, and up to a junction box (or a subpanel, if more than one circuit is necessary).

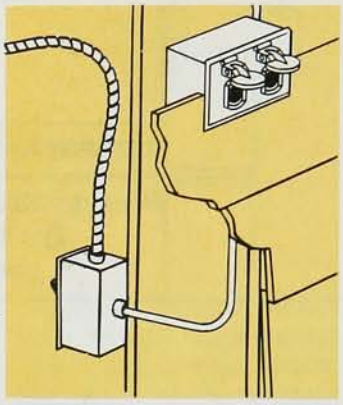
GROUNDING: If you are employing a grounded system, where the wiring is in conduit or in armored cable, here is good advice. On underground runs with dual-purpose plastic cable, use 2-wire cable with a bare ground wire. The bare wire provides a continuous ground connecting all boxes in the system, inside the house and those inside the new building you are wiring.

Use of a 3-way switch to control garage light



Enjoy electric living outdoors

Add an extra room to your house—big as all outdoors! Electricity will do so many wonderful things to make your patio, yard, garden lots more fun. All it takes is some judiciously spotted outlets that you can wire in yourself—and you'll have an exciting new way to live!

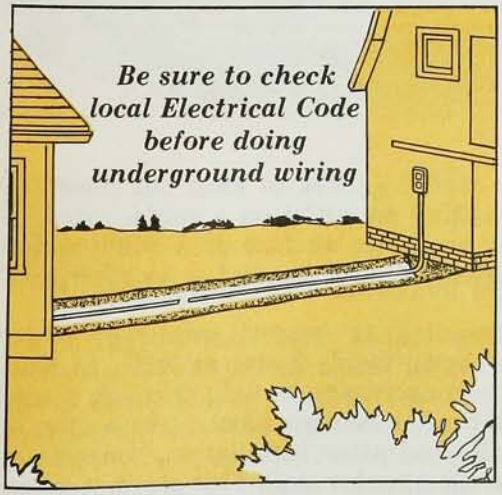


All you need is space—you can do the wiring!

Outdoor wiring differs from indoor only in the fact that moisture and weather have to be thought of. The least expensive method is shown below. A couple of tips. Plan a weatherproof outlet in front. Locate others near to where you'll use them. Avoid long extensions! Put plenty of weatherproof switches and outlets around, both single and double receptacle types. You'll find many uses for them!

Plan enough outlets for all outbuildings such as barns, garages, and workshops. Enjoy outdoor living electrically. Be able to plug in your grill, radio, or TV. Your roaster, percolator, toaster, rotisserie. Use lights to glamorize your patio parties.

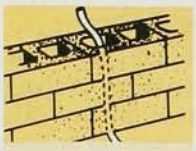
The National Electrical Code recommends Ground Fault Circuit Interrupter protection on all outdoor circuits. See page 51.



Low-cost plastic cable for underground wiring

The dual-purpose plastic cable described on page 18 makes underground wiring far less expensive and far easier to install than the conduit method ordinarily used. Plastic cable is ideal for farms, when wiring from one building to another, as it puts wiring out of the reach of damage from storms, high winds, falling trees or vehicle traffic. Water, acids or alkali can't harm it. There's little chance of interruption to your electric service with this modern system of underground wiring.

In some localities, the Local Code demands that only conduit or lead-sheathed cable be used for underground wiring. Be sure to check your own Local Code.



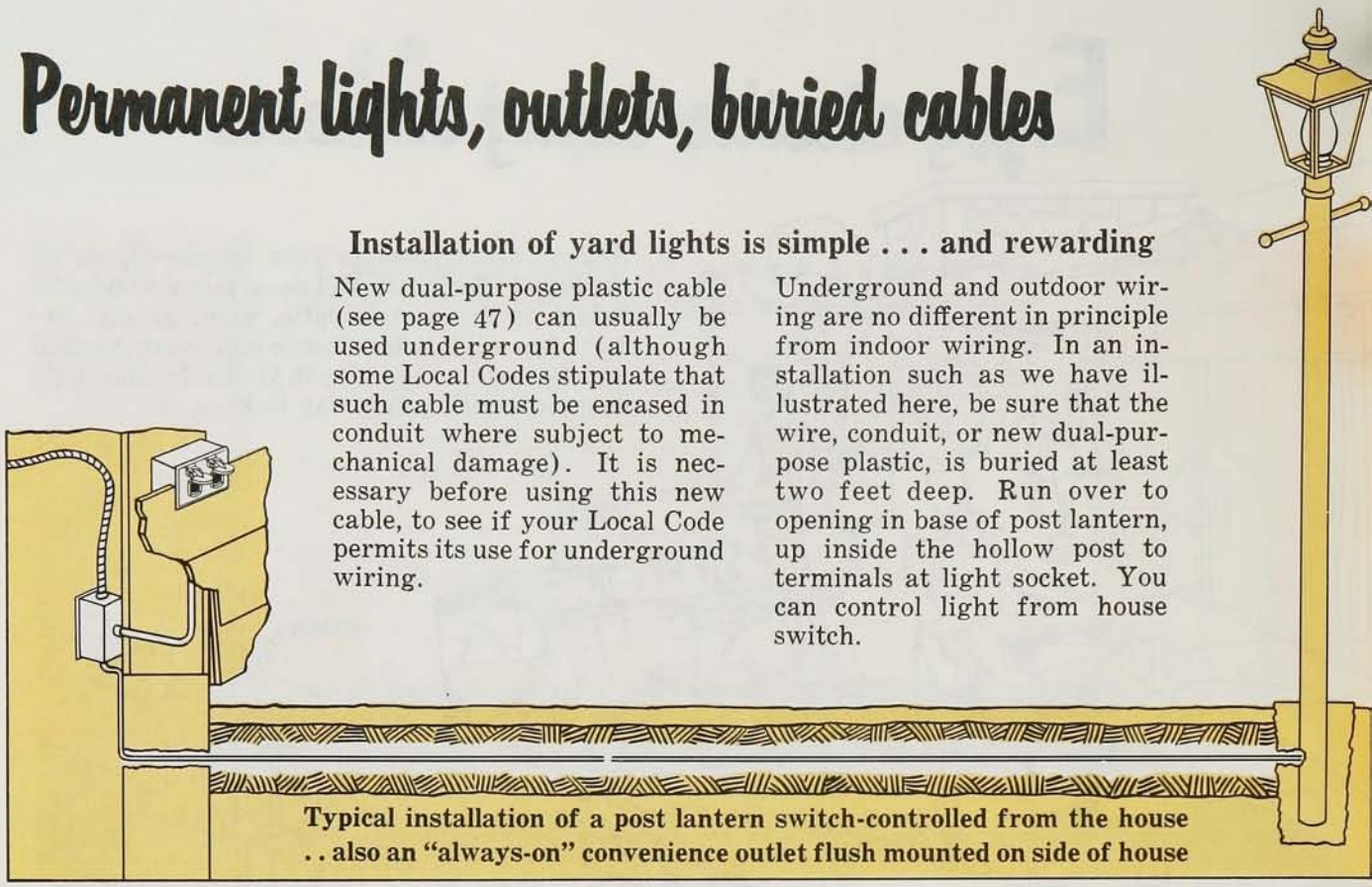
Plastic cable can even be run through concrete or masonry walls

Permanent lights, outlets, buried cables

Installation of yard lights is simple . . . and rewarding

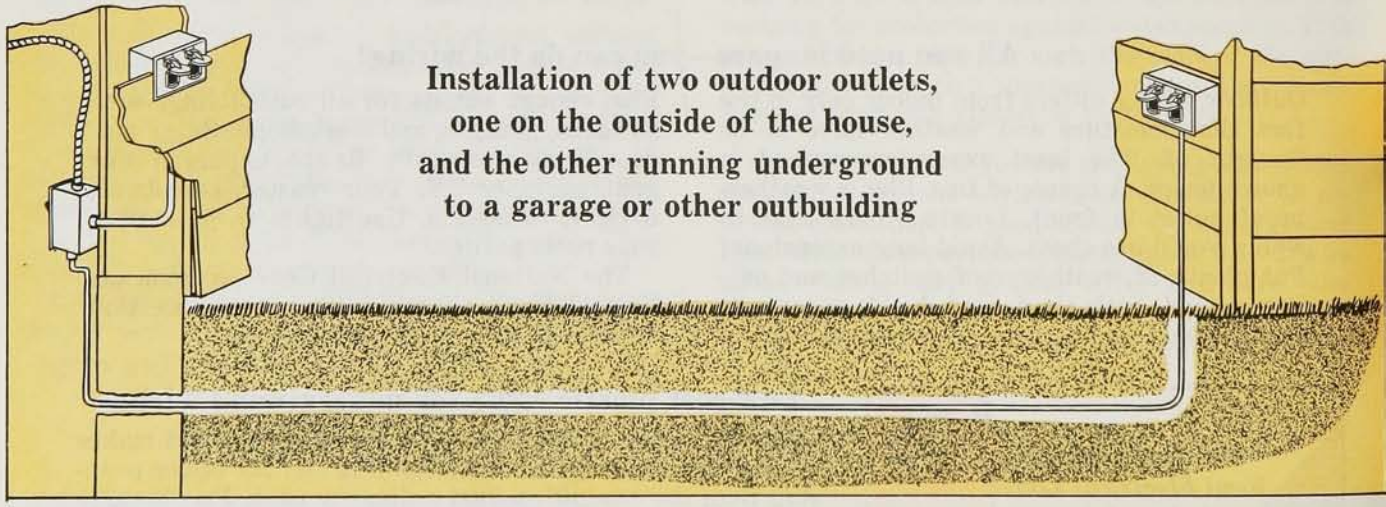
New dual-purpose plastic cable (see page 47) can usually be used underground (although some Local Codes stipulate that such cable must be encased in conduit where subject to mechanical damage). It is necessary before using this new cable, to see if your Local Code permits its use for underground wiring.

Underground and outdoor wiring are no different in principle from indoor wiring. In an installation such as we have illustrated here, be sure that the wire, conduit, or new dual-purpose plastic, is buried at least two feet deep. Run over to opening in base of post lantern, up inside the hollow post to terminals at light socket. You can control light from house switch.



Typical installation of a post lantern switch-controlled from the house . . also an "always-on" convenience outlet flush mounted on side of house

Outlets such as these have hundreds of different uses!



Installation of two outdoor outlets, one on the outside of the house, and the other running underground to a garage or other outbuilding

It's best to bury wire two feet or more underground to avoid injury from spading or digging. Better yet, bury it below frost line. This will prevent heaving and other cold damage. Use all wire and cable in unbroken lengths. Splices are made only in boxes designed for outdoor use. And, when mounting your weatherproof outlets, be sure they are above the "snow line."

When an outlet is recessed (mounted into the side of a building as shown above), use a standard outlet box with special weatherproof outlet cover. This has a rubber gasket to keep out moisture.

When installing an outlet on a surface such as on a post or the outer surface of a building, use a weatherproof outlet box, and a weatherproof outlet cover.

After connecting to nearest source of power (outlet box shown inside house at left), in most cases it will be necessary to drill through a concrete foundation or cement block. Use a star or masonry drill. And after installation, concrete or tar around cable at outer wall. This stops seepage.

3-light cluster for spotlight or flood bulbs

Use this weatherproof 3-light cluster indoors or out. The swivel holder can be mounted on wall or extension post. Superb for play areas or commercial installations such as drive-ins or parking lots to add highlights to general lighting. Adds to the beauty and use of lawn, garden or patio. Use wherever lots of light is needed to give almost daylight visibility—as for instance, chore areas around the farm. Ample light makes work easier, helps prevent accidents. Especially useful at night for repairing farm machinery in constant daytime use. Fits any 3¼ or 4-inch outlet box.

Portable spike-type units for lawns . .

. . uses spot or flood bulb. Swivel holder adjusts up or down—lets you actually "paint" with light. Steel post telescopes from 5 feet to 8 feet high. Ground spike has step plate for ease in puncturing hard soil. Weatherproof. Fine for outdoor parties, holiday lighting, or just to "sparkle up" your lawn. Complete with plug-in cord.

2-light cluster for spot or flood bulbs

Use indoors or out. Weatherproof. Wall-mounted swivel holder permits diffusing light as needed. Use for garden lighting, outdoor parties, after-dark outdoor work—or to lengthen hours of summer enjoyment out of doors. Also ideal for walks, driveways, over stairs, or garage doors. Can be post-mounted. Fits any 4-inch outlet box.

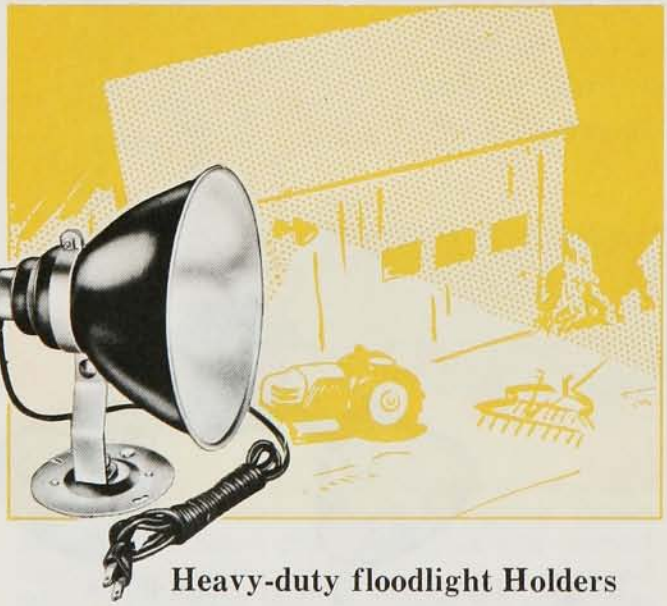
outdoor lighting beauty and comfort

Spike Lights for spot or flood bulbs

No installation problems—just push into the ground and plug into any 110-120 outlet. Swivel up or down. Put light where you want it—on trees, shrubs, flowers or house. Weatherproof. Fine idea for holiday lighting of outdoor displays or doorways. Complete with attached cord and plug.

Post and porch Lanterns for regular bulbs

Well-lighted driveways, sidewalks and doorways give a warm welcome to friends, in addition to helping prevent accidents caused by poor lighting. Mount porch lanterns to any 4-inch outlet box. Post lanterns are wired underground (see page 48). Both light from indoor wall switch.



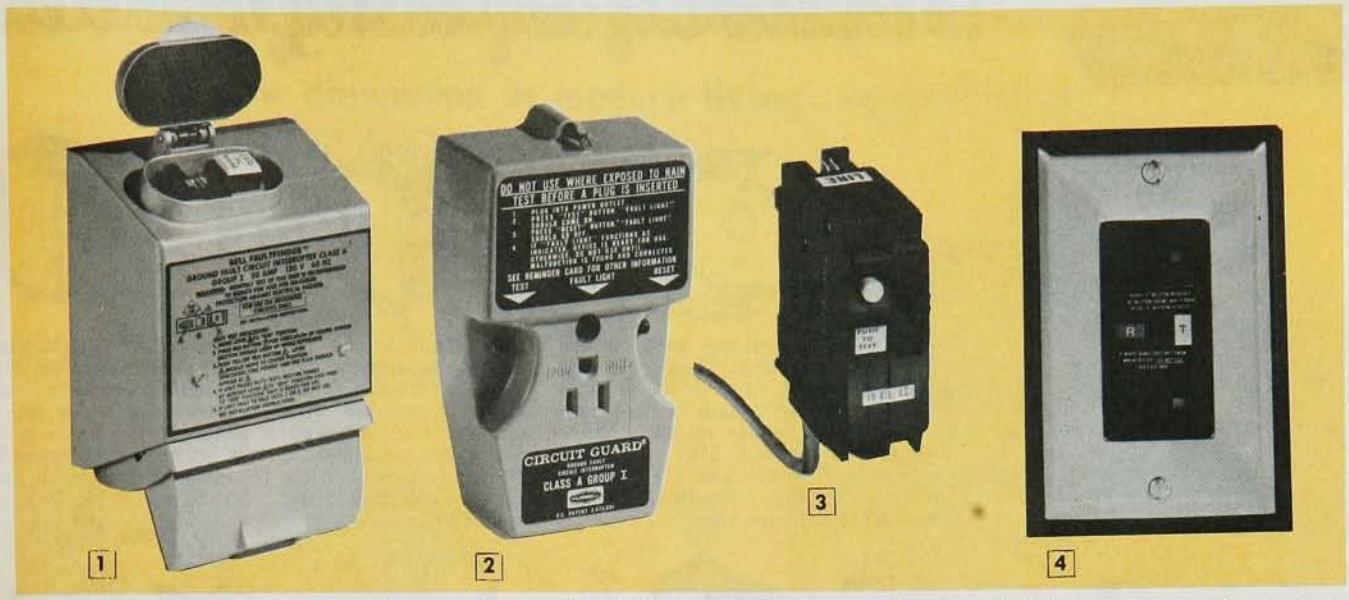
Heavy-duty floodlight Holders

Use with bulbs up to 200 watts. Adjust up or down for floodlighting or as all-purpose work light. Diffuses light over wide area through its closed-type, double-strength lens. Remove gasket, lens ring easily to change bulbs. Heavy gauge steel, dull black finish. Cord and plug. Mount on any flat surface or attach to any 4-inch outlet box.

Decorate with Garden Lights

What a warm, charming lawn or garden this decorative accent lighting gives you! Paint walks, shrubs, trees with soft light. Marvelously effective for lawn parties. Can be installed permanently using 2 or 4-foot posts . . or create a portable unit by using a spike adapter kit. Use regular 40 to 75-watt bulbs—white or colored.

Ground fault circuit interrupters



A relatively new product adapted for residential use is called the Ground Fault Interrupter (GFCI).

Fuses and circuit breakers protect circuits and wire against *overloads* and *short circuits* but not against *current leakage*.

Small amounts of leakage can occur without blowing a fuse or tripping a breaker. Under certain conditions the leakage can be hazardous.

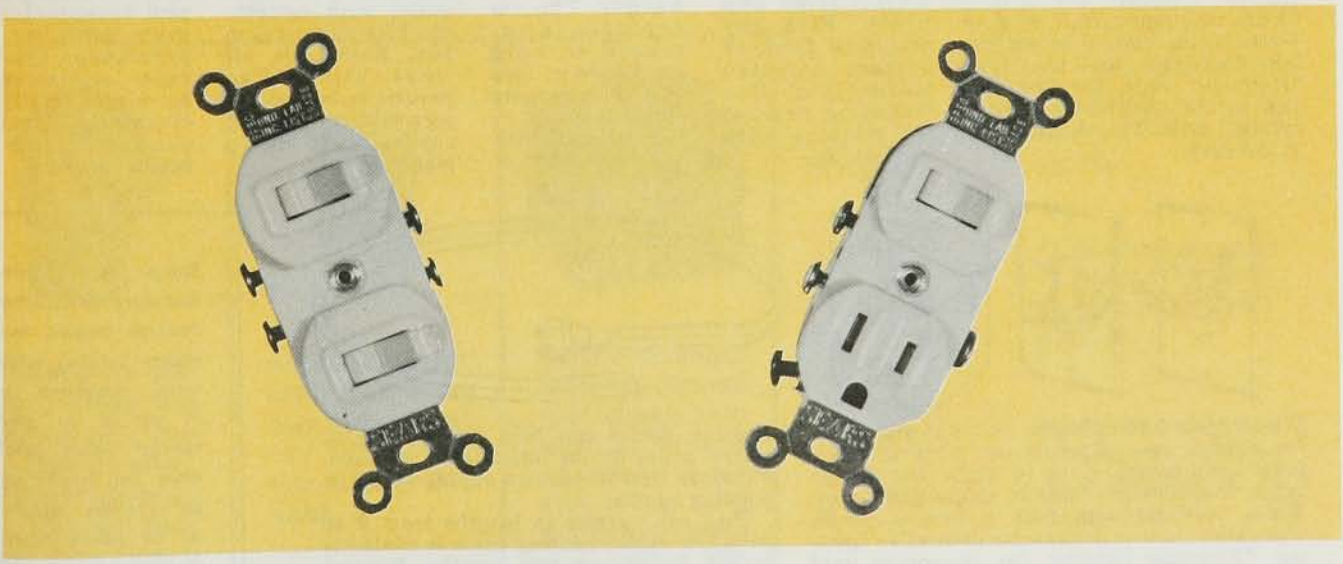
The GFCI is designed to detect and interrupt the power supply quickly enough to prevent a serious problem. After the problem is corrected the GFCI can be reset and power at that point will be restored.

The National Electrical Code recommends the use of GFCI's on all outdoor circuits. Local codes are especially strong on their use in conjunction with swimming pools that have any electrical connections. *Types*—All U.L. listed.

1. Designed for outdoor use—weatherproof, has 20A duplex receptacle.
2. Portable 15A unit designed for indoor use.
3. Breaker type fits only specific panels, check that point carefully. Available in 15 and 20A ratings.
4. Duplex wall receptacle which if wired first into series of receptacles can protect all other outlets on the circuit.

All come with complete wiring instructions.

Convenient combination devices

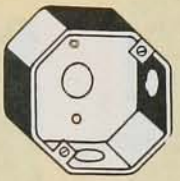


The twin combination switch is ideal for the situation when another switch is needed. You can save time and the effort of cutting the drywall and adding another box.

The switch and receptacle combination ideally provides an extra outlet without fuss or adding a new box. It can be wired in common or separately.

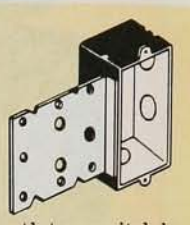
Modern devices easily installed

Converts fuse box into automatic circuit breaker. Just screw into fuse socket. Trips at once on overloads, but takes temporary overloads in stride. (Such as washer, etc.). Colored trip ring points out blown Circuit Saver. Simply push button to restore to use.



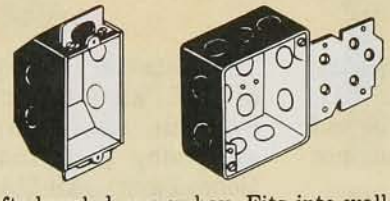
Octagon boxes for use with fixture or junction outlets. These are for use with conduit, or armored or non-metallic cable. Available in steel with half-inch knockouts or with cable clamps. Important hint: use bar hangers with studs wherever ceiling fixtures are to be installed. Recommended for in-home use.

Use steel boxes for switch, receptacle and bracket outlets in the home. Available with or without clamps. Gang two or more by removing one side plate on each box. Then hook boxes together.

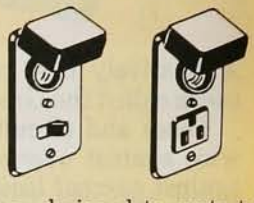


Steel outlet or switch boxes with wall mounting bracket. Mount brackets to allow correct depth for lath (or sheetrock), plaster or paneling. Available for use with connectors or with handy built-in clamps. Warning: use only in new work.

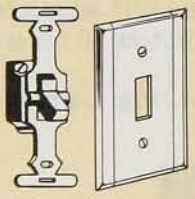
Plug and cartridge fuses with safety valves to protect wires against overloads. Fuse amperage should never exceed amperage capacity of the wire you are using.



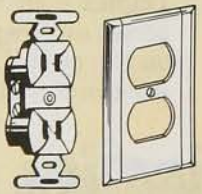
At left: beveled corner box. Fits into wall opening in old buildings. Has clamps for loom or non-metallic sheathed cable. No connector needed. Side-bracket box (center) used with cover (right) in new work, wherever extra space is needed for wires. Used for switches, receptacles, bracket outlets. Combination ½ and ¾-inch knockouts, requires connectors. Use with armored, non-metallic or plastic cable, or with conduit.



Fuse devices—designed to protect low ampere capacity motors on appliances, power tools, etc. Fit standard switch boxes. Device on the right has fuse holder for lag fuse; also a receptacle with "U"-shape ground. Device on the left has a fuse holder for lag fuse and a toggle switch.



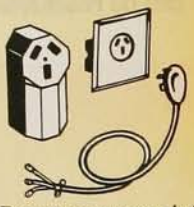
Bakelite toggle switch and plate fits any standard switch box. Choice of single-pole, 3-way or 4-way types, ivory or brown finish. Available too, in silent "Mercury" type, for bed and sick rooms. Also comes in illuminated type. Tiny bulb glows in the dark.



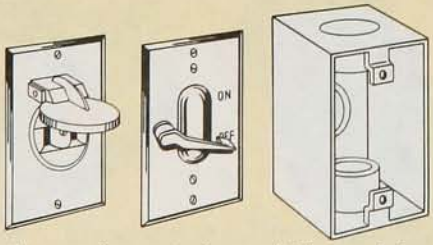
Bakelite duplex wall outlet and plate. Fits any standard flush or surface mounted switch box. Has mounting bracket for aligning with wall surface.

Clock outlet with hanger. The receptacle is recessed to hold both plug and wire. This permits electric clock to hang flush with any wall surface.

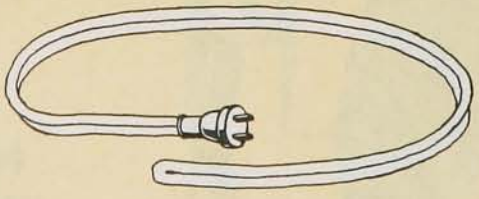
Porcelain pull chain outlet with receptacle. Fits any octagon box. Receptacle always "alive." Use porcelain to protect against rust and corrosion in damp places.



Dryer or range pigtails and receptacles are more convenient than permanent type because appliances can be moved easily for cleaning. Receptacle connects from entrance switch.



Weatherproof receptacles, switches and boxes for outdoor use. Receptacles, with weatherproof snap covers, come in single and duplex types. Switches available in single and 3-way. Boxes available with four ½-inch openings. Use these outdoor devices for decorative lighting, Christmas lighting, for temporary yard lighting, patio or garden lighting, or any other outdoor installation.



Heating cables can help prevent frozen water pipes or ice buildup in gutters. Flexible thermoplastic cables come in popular lengths.

Pipe cable comes in lengths from 6′ to 30′ while gutter heating cable is available in 25′, 50′, 75′ or 100′ lengths. Prevent costly repairs of frozen pipes or ice damaged gutters and ceilings.

Select these devices and many more, either through catalog mail order, catalog order store, telephone, or in person at your nearest Sears retail store. Top quality and performance assured on all Sears electrical devices.

Dial your light from Dim to Bright

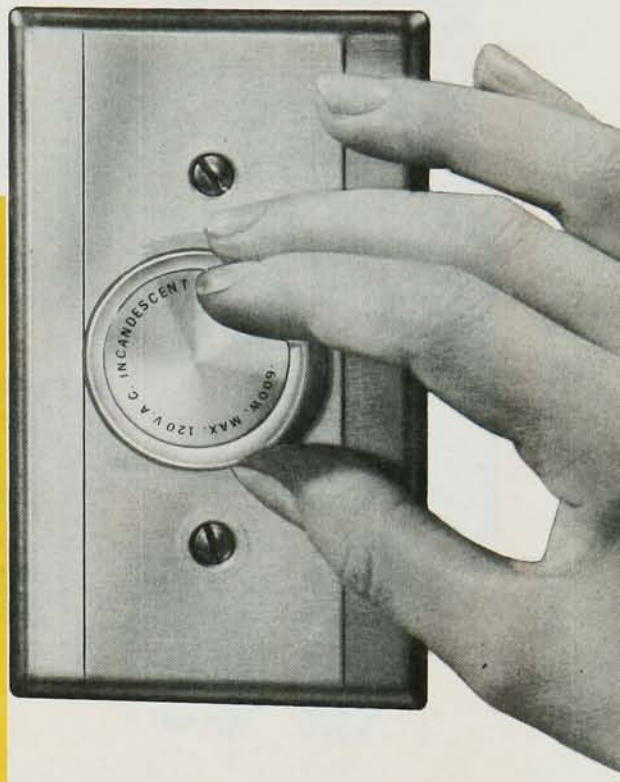
a new dimension in modern living..controlled light

SEARS Full-range Dimmer Control

Lets you set the light to suit your mood

DIM MEDIUM BRIGHT

Dim, medium, bright or anything in between! Provides completely variable dimming control from zero to full illumination without a flicker. Push type switch turns "on" to any pre-set dimming position. Have bright light if you wish, for festive occasions or for reading; have a lesser intensity for dining and then dim it even more for after-dinner conversation or for watching TV. You can also save electricity because it controls light intensity by controlling the amount used. Bulbs last longer, too. For incandescent only. "600 watt U.L."

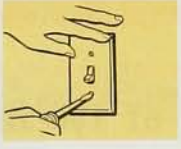


ECONOMICAL . . cuts down on electricity consumption when set at any point below full bright

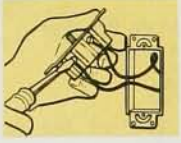
Replace old single or three way socket with new socket dimmer. Permits use of up to 150 watt bulb and dims from 0 to 100%.

Replace "cord" switch in swag light or lamp with full range dimmer rated at 200 watts.

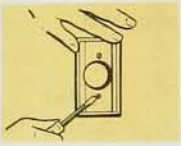
Quick and simple, table top dimmer just plugs into wall outlet and controls lamp with off-on or 0 to 100% dimming action rated 300 watts.



1 Turn off main switch and remove existing light switch.



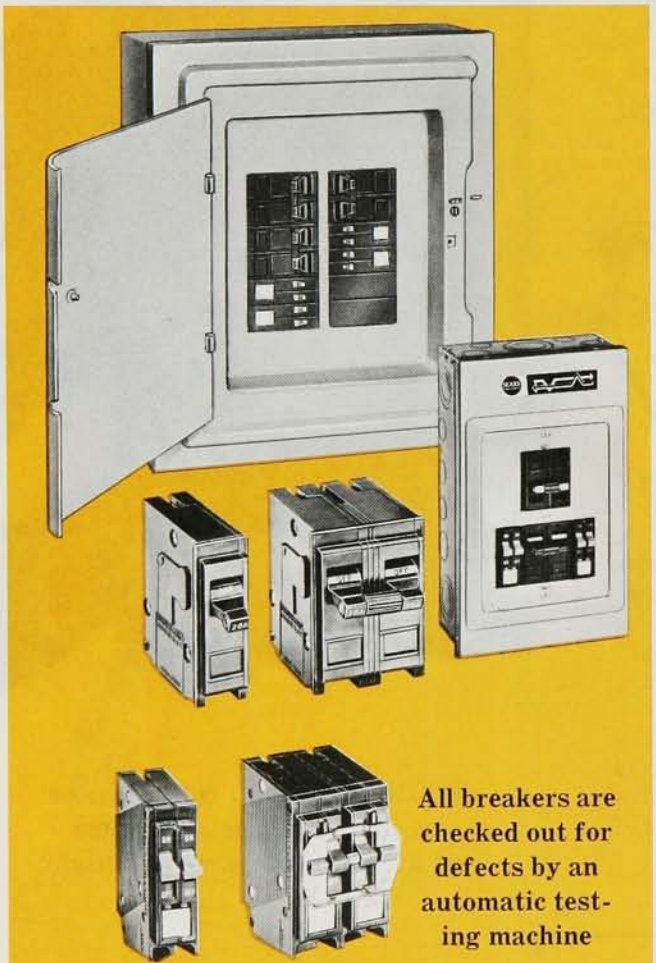
2 Connect wires to dimmer switch. Be sure it is in "off" position.



3 Attach wall-plate and knob and your installation is complete.

Modernize the fuseless way with a

No more fuses to change . . superior to fuse-type panels in convenience, safety and economy



All breakers are checked out for defects by an automatic testing machine

This is the kind of equipment that shows you ca about your home. It's the finest because it alwa carries a full-rated load; automatically stops flo of current if a circuit is shorted; takes harmle short-period overloads (starting of a washing m chine, an air conditioner, etc.) without trippin yet protects against the danger of prolonged ove loads. After the cause of the trouble has been l cated and corrected, just flip the circuit breake switch to restore power.

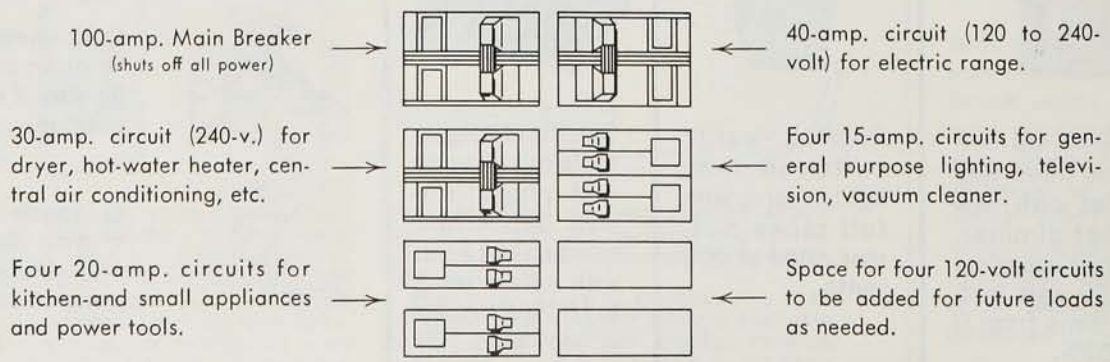
Our Sears panels come in a wide variety of size Some even come complete with both main an branch circuit breakers, others include main ci cuit breakers and you select your own branc breakers separately to suit your needs and simpl plug them into the panel. All panels are availabl for flush or surface mounting.

Provide for your future needs now

All panels are listed by Underwriters' Labora tories, Inc. and meet all REA specifications an national and local codes. You will be wise to choos one with the capacity for present and reasonabl future needs. It may cost a little more to begi with, but almost invariably proves to be worth i in the long run.

For recommendations as to the correct size fo your plans, see pages 8 and 9. Your local REA co operative or power company can also assist i determining your requirements.

Example of 100-ampere fuseless Service Entrance Panel



See our complete line of Entrance Panels and Circuit Breakers

...omplete Sears Electric Control Center

So simple to restore power.. just flip switch after correcting cause of trouble. Acts instantly on short circuits yet never trips unnecessarily.

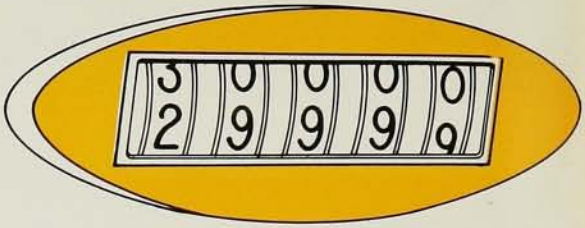
Modern, attractive styling. Paint is applied electrostatically to give it a rich, hard-shell finish designed to keep a like-new appearance for years.

Add-on Branch Circuit Breaker Panels

If you need additional circuits, install them with a Sears Add-on Branch Breaker Panel

You may find that your present main entrance panel has sufficient capacity to provide power for additional circuits but does not have any place left to put the necessary new circuits. In this case, you could provide from six to twelve new circuits for your system by installing a branch panel and connecting it to the power take-off lugs on the main entrance panel, thus saving the expense of installing a larger entrance panel.

Sears clicked this switch over 30,000 times



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